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NEW-WORLD SCIENCE SERIES

PRIMER OF SANITATION

BEING A SIMPLE WORK ON DISEASE GERMS AND HOW TO FIGHT THEM

BY

JOHN W. RITCHIE

PROFESSOR OF BIOLOGY, COLLEGE OF WILLIAM AND MARY, VIRGINIA

Illustrated by

KARL HASSMANN

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PREFACE

"WHAT you would have appear in the life of the people, that you must put into the schools," is the substance of the advice given by a German educator to his countrymen. The soundness of this advice has never been questioned, and the experience of the writer of this book has brought the conviction that in sanitary matters it can be applied with absolute literalness, — that our country can hope to shake off completely and permanently its burden of preventable disease only when the public schools give adequate instruction in the principles of preventive medicine and in the possibilities of public hygiene. The author has therefore followed with sympathy and very great interest the efforts that are being made to teach sanitation in the public schools, and has felt that the effectiveness of these efforts would be very greatly increased if they were supplemented by an elementary text-book in this field. With this in mind he has tried to write down in a simple manner, and in a form suitable for school use, the more important facts in regard to germ diseases and their prevention. The public side of the question has been given considerable space, because the relation of the government to the health of its citizens is an important and an intimate one, and because we seem destined to come into a realization of civic obligation largely through public sanitation.

To those who have given of their time to read the manuscript of this book, the author wishes to express his gratitude. They have corrected many errors in it, although they are, of course, in no sense accountable for any that may remain. They have also given many valuable suggestions as to method of presentation and subject-matter to be included, which have been taken advantage of in the final revision of the manuscript, as far as space would permit. The following, nearly

all of whom have read the entire manuscript, are among those to whom special thanks are due: Dr. H. A. Barbee, Dr. David P. Barrows (who first suggested the writing of this book), Miss Josephine K. Bauer, Dr. J. H. Billings, Dr. H. M. Bracken, Dr. Hiram Byrd, Professor J. S. Caldwell (joint-author of the Ritchie-Caldwell Series), Dr. E. C. Coleman, F. S. Crum, Dr. S. J. Crumbine, Commissioner E. G. Dexter, Dr. D. Harvey Dillon, Dr. F. B. Dresslar, Dr. William Ettinger, Professor Irving Fisher, E. Le B. Goodwin, Professor C. W. Hetherington, Frederick L. Hoffman, Dr. H. D. Holton, Dr. J. N. Hurty, President David Starr Jordan, Dr. J. M. King, Dr. James Lee, Dr. William F. Litterer, Dr. E. M. Mason, Miss Jessie B. Montgomery, Dr. William H. Park, Henry C. Pearson, Miss Mary D. Pierce, Dr. M. L. Price, Dr. C. O. Probst, Dr. E. P. Quain, Dr. C. A. Smith, Dr. Larkin Smith, Dr. William F. Snow, M. A. Spratt, Dr. Ç. W. Stiles, Miss Marion Talbot, Dr. H. H. Taylor, Dr. Louis A. Thomas, Dr. J. H. Townsend, Dr. T. D. Tuttle, Dr. W. L. Vercoe, Dr. Cressy L. Wilbur, Dr. E. G. Williams, Dr. R. C. Yenney.

To make sure that the health problems of every section of the United States were treated, the book was submitted in proof form to health officials and other medical authorities representing all the States. For the many hints and suggestions received from these sources, grateful acknowledgment is made, with regret that space does not permit personal mention of each reader.

With the hope that it may play some part in lessening the appalling economic and vital loss from preventable disease that is constantly sapping our nation's strength, this little book is sent forth.

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CHAPTER I

WHY THE STUDY OF DISEASE GERMS IS IMPORTANT

Suppose that in a happy and healthful village a strange plant should suddenly spring up and give off poisonous matter into the air. Suppose that every one who passed by it became ill, and that all the people who lived near it died because of the deadly gases from the plant. Would the people of the village allow that plant to ripen its seeds and scatter them abroad so that in a short time plants of the same kind would be growing along all the streets and in all the dooryards? Or would the people cut down the plant and destroy it root and branch?

Suppose that poisonous serpents should appear in a town and should attack the people. Would the inhabitants of that town allow the serpents to live and multiply in the streets and about their houses? Or would they hunt out and kill the reptiles that were doing them so much injury?

The people would certainly destroy both the deadly plant and the poisonous serpents, for no one would wish to suffer illness or death because of them.

Poisonous plants like the one described above do not exist, and, in most parts of the world, dangerous serpents are very rare. But in all the earth there is not a town or a village where there are not great numbers of very small plants and animals that attack the people and cause many of them to become sick and die. These

small plants and animals are called *disease germs*, and they cause many of the worst diseases that afflict mankind.

A blind man who attempts to walk through a wood is always groping and feeling his way even when there is nothing in front of him, and he bumps into the trees when there is plenty of room for him to pass between them. So a person who does not understand about germs often needlessly worries himself trying to escape them, and then in some simple manner allows the germs to get to him. In this book we shall study about disease germs and how to avoid them.

POINTS TO BE REMEMBERED

1. Everywhere very small plants and animals called disease germs are attacking people and causing sickness and death.
2. It is important for you to understand about disease germs in order that you may know how to escape them and that you may not be frightened when there is no danger from them.

CHAPTER II

THE CELLS OF THE BODY

As a house is built of bricks and a heap of sand is composed of a multitude of small grains, so is the human body made up of a great number of very small parts called *cells*. These cells are so small that we cannot

FIG. 1. When we look at a house from a distance we cannot see the bricks of which it is built.

FIG. 2. When we stand close to the house, we can easily see the bricks in the walls.

see them without a microscope, but if you could examine a small piece of skin or other part of the body under a microscope, you could very easily see the cells of which it is composed. The skin, the muscles, the liver, the stomach, the brain, and all the other body parts are built of these little cells.[1]

The cells are alive. Each one of the little cells of the body is alive. Each one takes in food and grows, and

[1] The cells of the body are exceedingly small. So small are they that it would take about 2500 of them placed side by side to make a row an inch long. There are 5,000,000 cells in a very small drop of blood and according to one estimate, 400,000,000,000 cells in the average human body.

does all those things that make a living being different from sticks and stones and other things that are not alive. When the cells are in health, the body is in health; and when the cells are dead, the body is dead; for the life of the body is in the cells of which it is built.

FIG. 3. When we look at the body, we cannot see the cells of which it is made But with a microscope the cells of the body are easily seen.

Keeping our bodies in health. Certain things are necessary to the cells of the body. They must have food, they must have oxygen from the air, they must get rid of their poisonous wastes, and they must have a constant temperature, neither too hot nor too cold. If our cells do not have all these things, they will die. They may be killed in other ways, too, as by being crushed, by electricity, and by poisons. To keep our bodies in health, therefore, we must supply our cells with the things that they need and we must keep poisons and other injurious substances away from them.

Disease germs. Our bodies are very wonderful machines, but sooner or later sickness comes to most of

us. Sometimes the stomach and other digestive organs fail to work properly, and then the cells suffer from a lack of food. Sometimes the heart and blood vessels become diseased, and then the blood fails to circulate

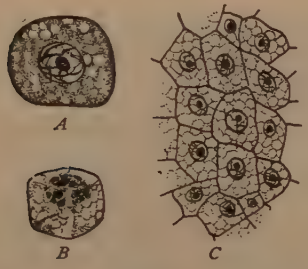


FIG. 4. *A* is a single cell as it appears under the microscope. *B* is a cell drawn to show that it has length, breadth, and thickness. *C* is a group of cells, showing how they are built together in the body.

FIG. 5. A section of the outer layer of the skin, as it appears under a microscope. The outer cells die and fall off as dry scales.

through the body as it should. Sometimes the kidneys fail in their work, and then the cells are injured by poisonous wastes. But the most common of all causes of sickness is that disease germs get into the body and poison the cells. In the next chapter we shall learn more about these small germs and how they cause disease.

POINTS TO BE REMEMBERED

1. The human body is built of very small cells.
2. The cells are alive.
3. When the cells are in health, the body is in health, and when all the cells are dead, the body is dead.
4. The cells must have food and oxygen, and they must not be poisoned or injured in other ways, or they will die.
5. Disease germs cause sickness and death by poisoning the cells.

CHAPTER III

DISEASE GERMS AND HOW THEY GET INTO THE BODY

Disease germs are the greatest enemies of mankind. Every day they kill thousands of people, and they cause the loss of an untold amount of time and money. To get an idea of the amount of sickness, sorrow, and loss that is caused by these small creatures, imagine a land where no colds, catarrh, consumption, influenza (grip), diphtheria, or pneumonia ever come; a land where boils, blood poisoning, and tetanus (lockjaw) are unknown; where there is no smallpox, measles, scarlet fever, whooping cough, or mumps; a land without malaria, cholera, leprosy, yellow fever, or plague; a land free from typhoid fever, and from many of the other diseases that afflict mankind. Picture to yourself a country and a people free from all these diseases, a country where many of the inhabitants pass from childhood to old age without sickness or disease, and you will have an idea of what a land without disease germs would be like.[1]

What disease germs are. In water and in the soil there are millions of little plants and animals — plants and animals so small that they can be seen only with a powerful microscope. The body of one of these little plants or animals is composed of a single cell. The little one-celled plants are called *bacteria* (singular, *bacterium*). The little one-celled animals are called *proto-*

[1] It is within the power of man to cause all parasitic diseases to disappear from the world. — Pasteur.

zoa (singular, *protozoön*). *Disease germs are bacteria and protozoa that grow in the body and poison the cells.*

Where disease germs come from. At this point you should get it firmly fixed in your mind that disease

FIG. 6. The great outdoor world is practically free from germs.

germs are living plants and animals; and that just as a pine tree can come only from the seed of a pine tree, or as a chicken can come only from the egg of a chicken, so a disease germ can come only from another germ of

the same kind. It is a common idea that germs spring from unclean and decaying matter — that "filth breeds disease germs" — but this idea is not correct. They are often found in unclean matter, and it is dangerous to have such matter about, because it furnishes a place where germs may multiply. But germs can no more originate in such matter than a cow can come from the grass in the pasture, or a stalk of corn can spring up where no grain of corn has been planted in the earth. *Nearly all the germs that attack us are spread from the bodies of persons who are sick with germ diseases.*

The world not swarming with disease germs. From the very beginning of your study of this subject you should clearly understand that the world is not filled with disease germs that are lying in wait to attack us. It is true that bacteria and protozoa are abundant in water, that bacteria are swarming in the soil, and that they are constantly being blown about in the air. But of all the many hundreds of kinds of bacteria and protozoa that are in the world, only a few cause disease. The others are harmless, and even when they get into our bodies, it is not we, but the bacteria and protozoa, that suffer. The germs of most diseases quickly die outside the human body. It is a mistake to think that every breath of air is dangerous, and that all food and water contain disease germs. The winds that blow over the meadows, the rain that falls from the clouds, the trees of the forest, the grass in the pasture, and in general the great outdoor world are practically free from germs. In the bodies of persons who are sick from germ diseases, in the houses where sick people live, and wherever the wastes from the bodies of the sick go,

there, and in most cases there only, are disease germs to be found.

The first great rule for the prevention of germ diseases. The first great rule for the prevention of germ diseases is: *destroy the germs that come from the bodies of the sick.* If all the diphtheria germs that come from human throats could be destroyed, there would soon be no more diphtheria. If all smallpox germs that come from the bodies of persons who have the disease could be destroyed, there would soon be no more smallpox. It is easier to destroy germs as they come from the bodies of the sick than it is to destroy them after they have been spread abroad, and a little intelligent care used in keeping germs from being scattered would every year save millions of lives.

FIG. 7. The germs that attack us come from the bodies of the sick.

How germs enter the body. Except in a few cases which we shall discuss later, germs do not pass through the unbroken skin, but *nearly all germs that enter the body get into it through wounds, or through the mouth or nose.* In later chapters we shall learn what germs get into the body through cuts and sores; we shall study about biting insects (mosquitoes, flies, ticks, fleas, and bedbugs) that pierce our germ-proof armor (the skin) and place germs directly in the wounds that they make. We shall read of other germs that enter the body by

way of the nose, and we shall learn how very dangerous germs may reach the mouth from flies, from the hands, from drinking cups, in food and water, and in many other ways. Here we wish only to call your attention to the fact that wounds (many of them made by insects), the nose, and the mouth are the gateways through which disease germs get into the body.

The second great rule for the prevention of germ diseases. The second rule for the prevention of germ diseases is: *take care of wounds, protect yourself from biting insects, and guard the mouth and nose.* The first rule aims to keep disease germs from being scattered abroad. The second rule aims to keep out of the body the germs that do get scattered abroad. If we neglect either of these laws, we cannot hope to escape the diseases that are caused by germs.

POINTS TO BE REMEMBERED

1. Disease germs kill more than half the human race.
2. Disease germs are very small plants and animals.
3. A disease germ can spring only from another germ of the same kind.
4. Nearly all the germs that attack us come from the bodies of sick persons.
5. The first great rule for the prevention of germ diseases is: *destroy the germs that come from the bodies of the sick.*
6. Germs enter the body through wounds, through the nose, and through the mouth.
7. The second great rule for the prevention of germ diseases is: *take care of wounds, protect yourself from biting insects, and guard the mouth and nose.*

CHAPTER IV

THE STRUGGLE BETWEEN THE BODY AND THE GERMS

In spite of the greatest care that we can use, all of us are certain at times to get the germs of very dangerous diseases into our bodies. Indeed, on the skin and in the throats of most persons, germs that can cause disease may at all times be found (pages 24, 43). Between these germs and the body there is never-ceasing war. The germs attack the body. They try to grow in it and use it for food. To defend itself the body kills the germs. Day by day and year by year the struggle goes on, the germs attacking, the body fighting to keep out the germs. In this chapter we shall learn how the body resists its small foes.

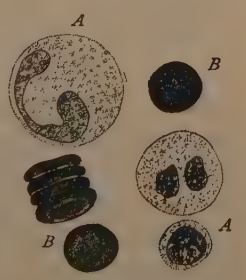


FIG. 8. *A* shows the white and *B* the red corpuscles of the blood as they appear under a microscope.

How germs cause sickness. When disease germs grow in the body, they produce poisons that are called *toxins*. These toxins are carried through the body in the blood, and cause sickness by poisoning the cells. A little group of tetanus (lockjaw) germs in a small wound, or a small patch of diphtheria germs growing in the throat, may produce enough toxin to poison and kill the whole body. Try to fix clearly in your mind that *it is not the germs themselves, but the toxins (poisons) that the germs produce, that cause the sickness.*

How the body destroys toxins. One way in which the body protects itself against germs is by producing *antitoxins*. When disease germs grow in the body and begin to poison it with toxin, the body begins to produce antitoxin. *The antitoxin does not kill the germs, but it does destroy the toxin*, and thus saves the cells from being poisoned until in other ways the body can kill out the germs.[1]

How the body kills germs. If you should examine a drop of blood with a microscope, you would find a very great number of cells floating in the liquid part of the

FIG. 9. A white corpuscle taking in a bacterium.

blood (Fig. 8). These cells are of two kinds. Most of them are red in color, and these are called *red corpuscles*. Their work is to carry oxygen through the body. The other kind of cells in the blood are the *white corpuscles*. These are the soldiers of the body, and *their work is to kill disease germs*.

A white corpuscle approaches a germ and flows about it, or swallows it, as you see in Figure 9. Then the corpuscle tries to digest and kill the germ, while the germ tries to grow in the corpuscle and use it for food. When the corpuscles are victorious, the germs are destroyed

[1] There is a different toxin and antitoxin in each different germ disease. The toxin and antitoxin of diphtheria, for example, are different from the toxin and antitoxin of tetanus or of typhoid fever.

and the disease is stopped. But if the germs are too numerous and too powerful, the corpuscles are killed, and the disease goes on until the body dies.

Besides the white corpuscles, there is another great defender of the body, the *germicidal* ("germ-killing") substance of the blood. There is always some of this substance in the blood of a healthy person, and when disease germs attack the body more of the germicidal substance appears in the blood and helps to kill them. In our fight against the germs this germicidal substance is perhaps even more important than the white corpuscles.[1]

Why we have certain diseases only once. When germs attack us, the body manufactures more of its germicidal substances to kill them. More and more of the germicidal substance is formed, and the blood becomes stronger and stronger in its power to kill germs. Finally, if the body is successful in its struggle with its enemies, the germicidal substance and the white corpuscles get the upper hand of the germs and recovery begins. After a patient recovers from some diseases (for example, smallpox, measles, and whooping cough), a large amount of germicidal substance remains in the blood for years, or even for life. Any germs of these diseases that get into the blood are therefore promptly killed, and a person is seldom attacked by one of these diseases more than once. After other diseases (for example, pneumonia, influenza, and colds), the increased power of the body

[1] The body produces different germicidal substances in killing the germs of different diseases, just as different toxins and antitoxins are produced in different diseases. A person therefore may have a great power of killing the germs of one disease, as, for example, smallpox, and at the same time fall an easy victim to consumption or some other disease.

to kill the germs quickly disappears, and we may have these diseases again and again.

Keeping up the resistance of the body to germs. Through all your study of germ diseases you should

FIG. 10. Dry feet, fresh air, and plenty of sleep help to keep up the power of the body to kill germs.

bear in mind the importance of keeping up the germicidal power of the body. All of us, without knowing it, take into our bodies the germs of deadly diseases. As the seeds of plants lie in the cold earth waiting for the warmth of spring to come, so these germs often lie in the body waiting for a chance to grow. The only safe way, therefore, is to keep the body always in health, so that it will be able to kill any disease germs that may enter it. Overwork, exposure to cold, wet feet, hunger, fatigue, worry, lack of fresh air, lack of sleep, alcohol — all of these things injure the body and lower its germicidal power. It is the duty of every one to keep himself in health — to care for his body intelligently and carefully — and to fail to do this is no more sensible than it would be sensible for the soldiers in a fort to open the gates and lie down to sleep in the midst of their enemies.

Alcohol and resistance to germs. Experiments on animals prove that alcohol lessens the power of the body to kill germs. When alcohol is given to rabbits it is not possible to save them from rabies (hydrophobia) by the Pasteur treatment (page 130). Other experiments show that the germs which cause boils and blood poisoning are able to attack rabbits that have had alcohol more easily than they can attack rabbits that have had no alcohol. Still other experiments show that animals which have been given alcohol cannot resist the germs of cholera, tetanus (lockjaw), and other diseases so well as animals which have not been given alcohol. Experiments like these leave no room to doubt that alcohol taken into the body lessens the power of the blood to kill germs.

Many physicians have long believed that this was true, for they have known that drinkers suffer far more from many germ diseases than do those who use no alcohol. A spell of drinking often brings on an attack of pneumonia, and the death rate from pneumonia is very high among drinkers. Consumption is also very common among drinkers, the records of one German life insurance company showing a consumption death rate more than five times as high among brewers as among Protestant ministers. Wounds heal less rapidly in users of alcohol than in abstainers, and the inflammation is more likely to run on into blood poisoning in a drinker. So in cholera and typhoid fever it is the drinkers who suffer most, and there is every reason to believe that this is the case in all germ diseases. Drink no alcohol if you wish to keep up the power of your body to resist germs, for users of alcohol are attacked by germ diseases more

frequently than abstainers, and many of them die of these diseases when they are attacked.

The third great rule for the prevention of germ diseases. The third great rule for the prevention of germ diseases is: *keep the body in health, so that it will be able to kill disease germs.* A general does not risk the fate of his army on a single battle line, but behind the first line of

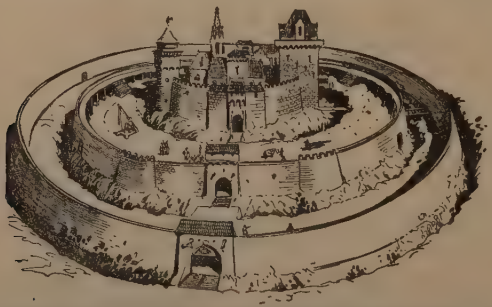


FIG. 11. The Castle of Health. Read the three rules for the prevention of germ diseases, and tell what the two outer defenses of the castle, and the walls of the castle itself, represent.

soldiers he places a second line, and behind the second line he has still a third line of defense in case the enemy should break through the first and second lines. So in our warfare with the germs we should not depend on any single line of defense. We should try to keep germs from being spread about, we should guard the gateways by which they enter the body, and within the body we should have the defenders at their posts. For sooner or later, just when we cannot tell, our unsleeping enemies will pass through the first and second lines of our defense, and if at that time the health of the body is low and the defenders of the body are weak, it will be the worse for us.

POINTS TO BE REMEMBERED

1. Dangerous germs often get into the body in spite of the greatest care that we can take.
2. These germs cause disease by producing toxins which poison the body.
3. The body defends itself by producing antitoxins that destroy the toxins.
4. The body kills germs by means of the white corpuscles and the germicidal substance of the blood.
5. We have certain diseases only once because after recovery from these diseases the germicidal substances remain strong in the blood.
6. The germicidal power of the body should not be allowed to run low, because disease germs may be in the body waiting for a chance to grow, or may get into it at times unknown to us.
7. Alcohol lessens the power of the body to kill germs.
8. The third great rule for the prevention of germ diseases is: *keep the body in health, so that it will be able to kill disease germs.*

CHAPTER V

BACTERIA

BACTERIA are the smallest of all living things. Millions of them have plenty of room to swim in a drop of water. Twenty-five thousand of them placed side by side would make a row only an inch long. Examined under a microscope that would cause a man to appear as high as Mt. Washington or Mt. Mitchell, these small plants look about as large as periods and commas in ordinary print. So exceedingly small are they that they can pass through the pores of a brick as easily as a man can pass through the doorway of a house.

The multiplication of bacteria. Bacteria multiply by simply pinching in two. Some of them can divide and

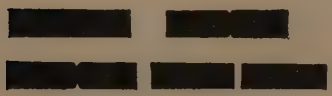


FIG. 12. A diagram showing the way a bacterium multiplies by pinching in two.

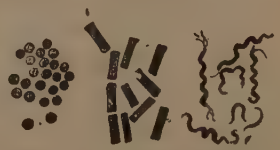


FIG. 13. The three shapes of bacteria, — cocci, bacilli, and spirilla.

become full-grown in fifteen or twenty minutes; but this, of course, is very rapid, even for a bacterium. They can easily divide once an hour, however, and at this rate one bacterium would increase in two days to 281,474,976,710,656; and in three days its descendants would weigh 14,835,600 pounds.

The shapes of bacteria. Bacteria are cylindrical, spher-

ical, or spiral — shaped like a fire-cracker, a marble, or a corkscrew. The cylindrical bacteria are called *bacilli* (singular, *bacillus*). The spherical bacteria are called *cocci* (singular, *coccus*), and the spiral forms are called *spirilla* (singular, *spirillum*). The shapes of bacteria have nothing to do with the diseases which they cause, but often give a convenient way of distinguishing between different kinds.

Where bacteria are found in nature. Bacteria are blown about in the air, clinging to particles of dust. They abound in the upper layers of the soil, but in ordinary soils do not live deeper than three feet below the surface. They are very abundant in the waters of streams, ponds, lakes, springs, and shallow wells, a quart of ordinary well water having in it something like a million of them. They are always found in great numbers about the bodies of men and animals, flourishing especially in the mouth, nose, throat, and intestine, and on the skin.

Dangerous, harmless, and useful bacteria. Some kinds of bacteria cause disease, and a few kinds are useful to man. Most of them, however, lead their little lives in the soil, in water, or even in our own bodies, and neither help nor harm us. Among useful bacteria are those that take a part in butter and cheese making, and those that help to increase the fertility of the land. The bacteria of decay, although they destroy much of our food, are also, on the whole, useful to us. Imagine what the world would be like if all the animals and plants that have lived and died in it were lying about us, and you will be convinced that the bacteria of decay are our friends and not our enemies.

The spores of bacteria. Certain kinds of bacteria produce *spores* when hard times come upon them. A spore is formed by the living matter of a bacterium gathering itself into a little, hard ball that rests, like a little seed, until food, moisture, and other good conditions for growth return. Then it grows again into an ordinary bacterium, which goes on growing and multiplying as before. So very difficult are bacterial spores to kill, that some of them have been found alive after they had been dried for ten years, and others are not killed by boiling them for several hours. Fortunately for us, the germs of none of our most common diseases produce spores, and these germs may be killed by a very moderate amount of heat (page 158).

FIG. 14. The right-hand figure shows a spore of a bacterium.

POINTS TO BE REMEMBERED

1. Bacteria are the smallest of all living things.
2. They multiply with astonishing rapidity by simply pinching in two.
3. A bacterium is called a bacillus, a coccus, or a spirillum, according to its shape.
4. Some bacteria are useful, and many of them are harmless, but a few kinds produce disease.
5. Some bacteria produce spores that are much harder to kill than are the bacteria themselves.

CHAPTER VI

THE SKIN

WITHOUT the skin to protect us, it is probable that bacteria would swarm into our bodies in such numbers that in a week there would not be a living human being in the world. We know that this is true, because most of the bacteria that attack us enter the body by way of two small openings (the mouth and the nose), and because when even a single cut or tear is made in the skin, the body is sometimes hardly able to hold back the germs. If the inhabitants of a besieged city were hard pressed to defend a single open gate of the city, we should not think that they stood much chance of holding back the enemy if the whole city wall were thrown down. So if the body is hardly able to defend itself when there is only one wound in the skin, we should not expect it to keep up the fight long if the covering behind which it is sheltered were removed.

FIG. 15. A section of the skin.

The structure of the skin. The skin is composed of an inner layer called the *dermis*, and an outer layer called

the *epidermis*. The hairs stand in deep narrow pockets that are called *hair follicles*. Through the epidermis, the sweat glands open on the surface of the skin by little pores or openings.

Bacteria that enter the body through the skin. The weak places in our armor of skin are the hair follicles and sweat glands. Through these weak points certain

FIGS. 16 and 17. If bacteria were large enough for us to see them without a microscope, a pencil that had been in some one's mouth would appear something like this, and the legs of a fly would be seen to be loaded with germs.

bacteria do sometimes work down and cause inflammation, pimples, boils, carbuncles, and erysipelas. These same bacteria also enter the body through wounds, and a considerable number of other disease-producing bacteria get into the body either through wounds or by the bites of insects.

Bacteria real living plants. In the next chapter we shall discuss the bacteria that enter the body through the skin. During your study of this chapter, as well as during your study of later chapters, it will help you greatly if you can get a clear picture in your mind of what bacteria are really like. Remember that the moss which clings to the bark of a tree is on the tree, even

though you cannot see it from a distance. So if you could only see them with your unaided eyes, there are, as it were, great forests of bacteria growing on your skin, and clusters of bacteria hanging to particles of dirt and to the legs of flies. Whether we see them or not, bacteria are real living plants, and you should be able to call up pictures of these little plants in your mind.

You can help yourself to get clear and correct ideas in regard to bacteria by asking your teacher about the points that you do not understand, and you can learn much about them from a physician. For physicians know many things about bacteria that are not found in a little book of this kind; they can tell you many things that a teacher cannot be expected to know; and sometimes they allow boys and girls to look at bacteria through their microscopes.

POINTS TO BE REMEMBERED

1. The work of the skin in protecting us from germs is very important.
2. The skin has two layers, the dermis and the epidermis.
3. The hairs stand in small pockets in the skin that are called hair follicles.
4. The sweat glands lie in the dermis and open on the surface of the skin from below.
5. Certain disease-producing bacteria enter the body through the hair follicles and sweat glands, through wounds, or from the bites of insects.

CHAPTER VII

THE PUS-FORMING BACTERIA

THE pus-forming germs are among the most widespread of all the germs that are capable of causing disease. They are found in the soil around the dwellings of men and of animals, they are common in unclean water, and they always occur in great numbers on the human skin, where they feed on the dead cells and other matter on the skin. There are several different kinds of these bacteria, but they all cause inflammation and form pus, the thick, creamy, liquid matter that is found in boils and infected wounds.

Diseases caused by pus-forming bacteria. The pus-forming bacteria may grow in almost any part of the body and cause inflammation of the part that is attacked. In wounds they cause pus to be formed. In the skin they cause pimples, boils, carbuncles, and erysipelas. Very commonly they attack the walls of the throat or intestine and cause tonsillitis, sore throat, inflammation of the bowels, or appendicitis. Occasionally they attack the membranes around the brain and cause meningitis, or set up their growth in the lungs and cause pneumonia. In like manner they may grow in the lining of the heart, or they may spread through all the body and cause blood poisoning.

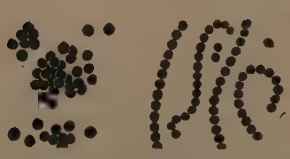


FIG. 18. The two most common pus-forming germs.

The different kinds of pus-forming bacteria. The most

common of the pus-forming bacteria is a small coccus (*Staphylococcus*[1]) that grows in bunches or clusters (Fig. 18). This coccus is the usual cause of pus in small wounds, of pimples, boils, and carbuncles, and of inflammation and ulcers in the bones. It may also cause blood poisoning, and is sometimes found in other cases of inflammation.

Another common pus-forming bacterium is a coccus (*Streptococcus*[2]) that grows in chains. This germ causes erysipelas by making a wide-spreading growth in the skin. It is sometimes found in small sores and boils, but it more commonly attacks the inner parts of the body. It is often the cause of tonsillitis, appendicitis, and blood poisoning. More commonly than any other germ it is found in inflammation of the middle ear,[3] and it causes meningitis and pneumonia more frequently than do the other pus-forming bacteria. It is the most dangerous of all the pus-forming germs.

FIG. 19. A pus-forming bacillus.

A third pus-forming bacterium is a slender bacillus (*Bacillus pyocyaneus*[4]) that sometimes gets into wounds and causes bluish-green pus to be formed. It is not so common in the body, nor is it so dangerous, as are the other kinds of pus-forming germs.

Weak and strong races of pus-forming bacteria. Some

[1] Pronounced stăf-ĭl-ō-kŏk′-kŭs.

[2] Pronounced strĕp-tō-kŏk′-kŭs.

[3] The running ears that are common among children should receive prompt medical attention, both because there is danger of injury to the hearing, and because there is danger that germs will work their way through from the ear to the brain and cause meningitis.

[4] Pronounced pī-ō-sī-ā′-nē-ŭs.

varieties of the pus-forming germs seem to be entirely harmless. Others are exceedingly dangerous, and whenever they have the opportunity produce the most violent cases of inflammation and blood poisoning. None of them should be allowed to enter the body when it can be prevented; but germs from a carbuncle, an old abscess, a case of erysipelas, or a case of blood poisoning are far more to be feared than germs of the same race from the skin or from some other source outside the body. It is a common thing for a person with a boil to scratch the germs into the skin with his fingernails, and cause a whole crop of boils in different parts of the body.

Care of wounds. For our protection against pus-forming germs it is very important to know how to care for small wounds. If the wound has been made by a clean instrument and bleeds freely, the blood will wash the germs outward, and by its germicidal power will probably kill any bacteria remaining in the wound. In such a case, the best thing to do is to tie up the wound "in the blood," and not open it until it is healed, unless inflammation sets in. A good plan is to wrap the wounded part in a thin, clean, inner cloth, and outside of this tie a second cloth. The outer cloth can be changed from time to time when it becomes soiled, while the inner cloth is left undisturbed to keep germs from getting

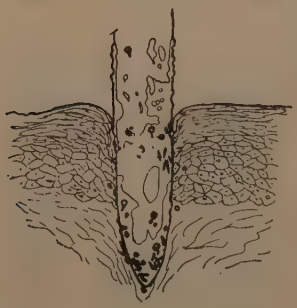


FIG. 20. If a nail or other instrument is driven through the skin, it will carry germs down and leave them among the cells.

into the wound. Wounds on the feet and hands, where dust and earth are likely to get into them, should have especially careful attention.

A wound that has been made with anything unclean should be carefully washed in pure water, and where particles of earth or other matter have lodged in the wound, it is often advisable to use a clean cloth and pure soap in removing them. Where there is much dirt in a wound, the wound should be washed with a weak disinfectant, as carbolic acid or biniodid of mercury (page 159). It is not best, however, to wash a wound with very strong disinfectants, for these disinfectants injure the cells in the wound and weaken their resistance to the germs. Turpentine is an excellent agent with which to treat a wound, and one that is often at hand.

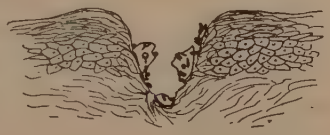


FIG. 21. Disease germs may be clinging to particles of dust that get into a wound. Therefore all dirt should be washed out of wounds.

After a wound has been bandaged, it should be carefully watched, and if pain, redness, or swelling shows that germs are growing in it, the wound should be opened and disinfected. A salve, such as carbolated vaseline, that contains carbolic acid, is often very useful in treating small infected wounds, and peroxid of hydrogen is used to flush out larger wounds and boils and to kill the germs in them. Peroxid of hydrogen must be used with care, however, or the tissues will be injured by it.

The pus-forming bacteria injurious to the body. It is a common belief that boils, pimples, and wounds that refuse to heal are signs of "impure blood," and it is

sometimes thought that boils are beneficial to the body. These ideas are not correct. When pus-forming bacteria are able to set up their growth in the body, it means that the blood is weak in its power to kill germs, and not that there is any impurity in the blood. To have pus-forming bacteria kill patches of the cells and poison the whole system with their toxins, no more benefits the body than it would benefit it to be attacked by the germs of typhoid fever, pneumonia, or diphtheria. A person who has pimples, or wounds that refuse to heal, should, therefore, examine his mode of living and see why his body is so weak that the germs are beginning to gain a foothold among the cells.

POINTS TO BE REMEMBERED

1. The pus-forming bacteria may grow in almost any part of the body.
2. These bacteria cause inflammation, pus formation, pimples, boils, carbuncles, erysipelas, tonsillitis, appendicitis, blood poisoning, and many other diseases.
3. There are weak and strong races of pus-forming bacteria, and the strong races are greatly to be feared.
4. Wounds should be cared for, to keep germs from growing in them.
5. The growth of pus-forming bacteria in the body is a sign that the body is weak and that the health needs attention.

CHAPTER VIII

TETANUS (LOCKJAW)

TETANUS is not a very common disease, but it is a most severe one. It affects chiefly man and the horse, but other animals may suffer from it. The incubation period (the time from the entrance of the germ into the body to the appearance of the disease) is usually from four to fourteen days.

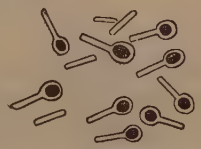


FIG. 22. Germs of tetanus. Most of them have formed spores.

The germ of tetanus. The germ of tetanus is a rather long bacillus. It forms spores that are very difficult to kill (page 20). The natural home of the tetanus bacillus is in the soil, but it is swallowed by grass-eating animals, such as the cow, sheep, and horse, and not uncommonly grows in the intestines of these animals (especially in the intestine of the horse) without causing disease. It is therefore very common about stables.

So abundant are tetanus germs in certain kinds of soil that a handful of earth from a barnyard is almost certain to contain them, and the savage tribes of the New Hebrides Islands poison their arrows with tetanus germs by smearing them with earth from crab holes in swamps. A peculiar thing about the tetanus bacillus is that, unless other bacteria are present, *it cannot grow except when shut away from the air.* Along with other germs, however, it sometimes grows in an open wound.

How the tetanus germ enters the body. The tetanus germ enters the body through wounds, sometimes

through wounds so small that they are not noticed. It is most frequently found in wounds made by unclean instruments, because such wounds are most likely to get tetanus germs into them, and because dirt and other bacteria are left in wounds of this kind. It grows best

FIG. 23. Wounds made by these are often infected with tetanus germs.

of all in small, deep wounds, like those made by an unclean nail, because such wounds readily close over and leave the tetanus germ, with other germs and dirt, buried deep in the flesh. The percussion caps used on toy pistols, blank cartridges, and firecrackers also make dangerous wounds. The tetanus spores are in dust on the skin, and the small, sharp, flying particles of the cap, the wads of the blank cartridge, or pieces of the firecracker cut deep into the flesh and drive down these spores along with other bacteria and dust.

The importance of disinfecting wounds. The bacillus of tetanus is so common that undoubtedly it often gets into wounds in which it never grows. Its home, indeed, is in the earth, and it grows in the human body only when it finds conditions favorable. The disease is so danger-

ous, however, that it is always wise to look after and protect every wound, especially since the same measures that cleanse a wound of tetanus germs will also free it from pus-forming bacteria. Wounds made by unclean instruments should therefore be carefully disinfected. Wounds on the feet of barefooted children also should receive careful attention, since these will come in contact with the earth and probably will get tetanus germs into them. It is best to have a physician look after a wound that is especially likely to furnish a favorable place for the growth of tetanus germs; for usually the disease develops suddenly and without any symptoms, often days after the wound is supposed to be healed.

The toxin of tetanus. The tetanus germ makes only a very little growth in the body, but it produces a toxin of tremendous power. This toxin for man is a poison twenty times as strong as dried cobra venom, and almost three hundred times as strong as strychnin. It poisons the nervous system and causes all the muscles to be thrown into contraction. One of the first symptoms of tetanus is a stiffness of the muscles of the jaw and neck.

Tetanus antitoxin. An antitoxin for tetanus is prepared from the blood of the horse, but it has not proved very valuable in curing the disease, except when used in the early stages and in large doses. It is very valuable, however, in preventing the disease, and when a person has received a wound that is likely to bring on tetanus, a dose of the antitoxin should be given. When this is done, the disease is almost certain to be prevented.[1]

[1] In 1903 there were in the United States 406 deaths from tetanus following 4449 Fourth-of-July injuries, while in 1907, when antitoxin was more extensively used, there were only 62 deaths from 4413 injuries.

Other disease-producing bacteria in the soil. Several other germs that are relatives of the tetanus germ have their home in the soil and in dirty water. One of these (*Bacillus aërogenes capsulatus*) produces a terrible inflammation and swelling. A wound that is infected with this germ is filled with gas and has a very ill-smelling odor, and the inflammation is likely to run into gangrene. This bacillus, like the tetanus bacillus, does not often grow in an open wound. It is dangerous enough, however, to give another powerful reason for looking after wounds and protecting them from dirt. Another relative of the tetanus bacillus causes the disease called "blackleg" in cattle.

POINTS TO BE REMEMBERED

1. The tetanus bacillus has its home in the soil and is commonly found about stables.
2. It enters the body through wounds.
3. Usually it grows only in deep wounds and in wounds that dirt gets into.
4. Wounds of a kind that are especially likely to bring on tetanus should be looked after by a physician.
5. The toxin of the tetanus germ is extremely powerful.
6. Tetanus antitoxin is more useful in preventing tetanus than in curing it.
7. It is advisable to give a dose of tetanus antitoxin as a preventive measure when a wound that may cause the disease to develop has been received.
8. Several dangerous bacteria besides the tetanus bacillus live in the soil.
9. The presence of these germs in earth makes it the more necessary to care for wounds.

CHAPTER IX

THE AIR PASSAGES AND THE LUNGS

THE air passages consist of the *nasal chambers* (nose), the *pharynx* (throat), the *larynx* (voice box), the *trachea* (windpipe), and the *bronchial tubes*. The lungs are composed chiefly of air passages (bronchial tubes), some of which are very fine, and of millions of thin-walled little air sacs that lie at the ends of the bronchial tubes. The tonsils are two rounded elevations in the side walls of the pharynx. A tube from each of the middle ears opens into the pharynx.

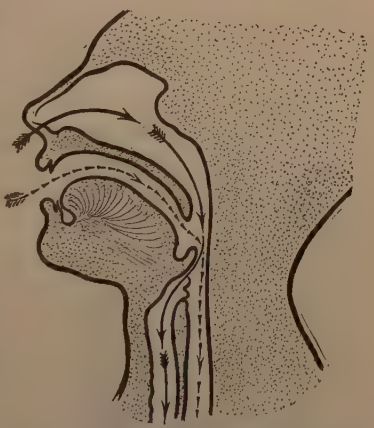


FIG. 24. The solid arrows show the path of the air to the lungs; the dotted arrows show the path of the food to the stomach.

Why bacteria are abundant in the air passages. The air passages have a warm, moist lining on which many kinds of germs can grow and multiply. They open to the outside air, and if germs enter either the nose or the mouth they have no difficulty in reaching any part of the air passages or the lungs. In the colder regions of the earth from one third to one fourth of all deaths are due to respiratory diseases (diseases of the lungs and air passages) — more deaths than are caused by any other group of diseases.

Bacterial diseases of the air passages and lungs. Among the common bacterial diseases of the air passages are *colds*, *catarrh*, *influenza*, *tonsillitis*, *bronchitis*,

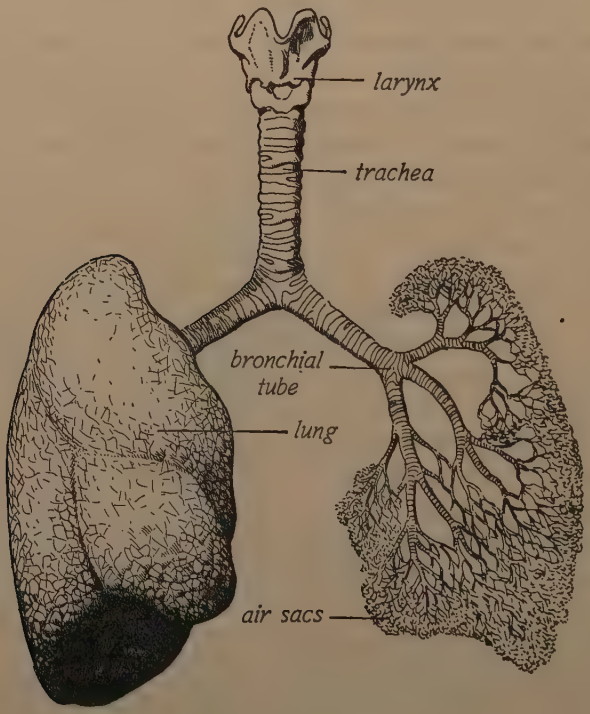


FIG. 25. The lungs.

diphtheria, and probably *whooping cough*. The most dangerous diseases of the lungs are *consumption* and *pneumonia*, the two diseases that in the United States stand at the head of the list as causes of death.

The importance of guarding against respiratory diseases. Simply reading the above list of diseases will convince you that *it is very important to destroy the germs of respiratory diseases.* It will also convince you that *it is very important to guard the entrance to the air passages.* It is difficult, however, to guard against these bacteria, because they are very widely scattered among mankind, and because some of them withstand drying and live for a considerable time outside the body. *It is exceedingly important, therefore, to keep up the health as a defense against colds, pneumonia, consumption, and other respiratory diseases.*

FIG. 26. Air sacs that lie at the ends of the small bronchial tubes in the lungs.

POINTS TO BE REMEMBERED

1. The air passages and lungs are favorable places for the growth of germs.
2. From one third to one fourth of all deaths in our country are due to bacterial diseases of these parts.
3. The germs of respiratory diseases are widespread.
4. The germs of these diseases should be destroyed, and the entrances to the air passages should be guarded.
5. The greatest protection against some respiratory diseases is a strong, healthy condition of the body.

CHAPTER X

DIPHTHERIA

Some cases of diphtheria are so severe that death comes in a day or two. Other cases are so light that they are mistaken for colds in the head or for simple sore throats. The disease is most common in children, and there is always an increase in the number of cases when the children come together in school after the long vacation. The incubation period is usually from two to eight days, but may be less.

The germ of diphtheria. The diphtheria germ is a bacillus. It grows most frequently in the throat, but often it is found in the mouth, nose, and larynx.[1] It may grow also on the lips, on the lining of the eyelids, and in other parts of the body.

Fig. 27. The bacillus of diphtheria.

The diphtheria bacillus does not usually grow outside the human body, except when it gets into milk. In most cases it is killed by drying, but when it is protected by matter about it, the bacillus can live for some time. On slate pencils that had touched the lips of children who were in the early stages of diphtheria, the germs were found to be alive after several days, and in dried "membranes" from the throats of diphtheria patients it is known that the germs can live for months.

[1] Diphtheria of the larynx is the disease often called membranous croup.

How diphtheria germs get into the body. Diphtheria germs enter the body by way of either the mouth or the nose. They are passed from one person to another in various ways. They may be coughed out into the air and inhaled,[1] or by spitting they may get into dust and be blown about in the air. They are almost certain to get on the handkerchiefs of the persons who are carrying these germs, and they can easily get on doorknobs, books, or furniture. They have been found on public drinking cups, and they may be on pencils, chewing gum, pieces of candy, toys, or any of the other objects that are handled and passed around by children. A number of diphtheria epidemics have been caused by milk (page 154), and flies may carry the germs about and leave them where they will reach the mouth and throat. There is little doubt that domestic animals, especially cats, suffer from diphtheria and spread the disease.

FIG. 28. Diphtheria germs have been found on pencils.

[1] In coughing, sneezing, laughing, and to a certain extent in talking, small droplets of liquid are sent out into the air. They may fly to a distance of several feet (three to nine), and some of them are so very fine that they are said to float in the air for as long as twenty minutes. When a person is suffering from a disease like diphtheria, pneumonia, or consumption, these droplets are, of course, filled with the germs of the disease. One should not stand near a person who is coughing, and a sick person should hold a handkerchief or a paper napkin before his face when he coughs.

Difficulties in controlling diphtheria. In spite of quarantining and the use of antitoxin, there were over 17,000 deaths from diphtheria in the United States during 1907. The chief difficulty in stamping it out is that the germs often linger in the throat for four or five weeks, and occasionally for several months, after recovery from an attack of diphtheria. The germ is found also in the throats of a considerable number of healthy persons [1] (almost always those who have been in contact with cases of the disease), and in the noses and throats of persons who seem to be suffering only from ordinary colds or from light cases of sore throat. As a fire sometimes bursts forth into flames again after it seems to be dead, so diphtheria, after it seems to have disappeared, often breaks forth anew from these germ carriers. For at any time one of these persons may pass on to others germs that will cause the most severe cases of the disease; or if his resistance to the germs runs low, he himself may be overcome by them.

Quarantining in cases of diphtheria. To control diphtheria, every one who is carrying virulent diphtheria germs must be shut up in quarantine, whether he be sick or well. It should be understood that in doubtful cases it is not possible for a physician to tell by looking at the throat whether or not it is free from diphtheria bacilli.

[1] Investigations indicate that when diphtheria is in a city or town, two or three healthy persons in every thousand carry virulent diphtheria germs in their throats. In these persons the body is holding the germs in check so that they cannot multiply enough to produce the disease, but it is not able to kill them out entirely. The difficulty of controlling the disease is still further increased by the fact that there seem to be harmless races of the germs, and it is not desirable to shut up in quarantine any persons except those who are carrying the dangerous varieties.

To determine this, a microscopical examination for the germs must be made.[1]

Diphtheria toxin. The diphtheria germ occasionally produces death by causing the throat to close, but the usual cause of death in diphtheria is the very powerful toxin. So poisonous is this toxin that a patch of diphtheria germs the size of the thumbnail growing on the tonsil may produce toxin enough to cause death. The toxin attacks especially the nervous system, the kidneys, and the heart.

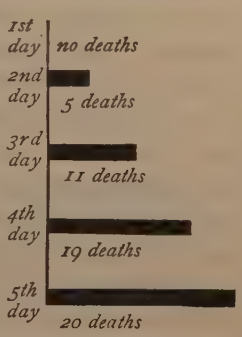


FIG. 29. Showing the number of deaths in 100 cases of diphtheria when antitoxin is used on the first, second, third, fourth, and fifth days. The sooner antitoxin can be used in this disease, the better. The figures are taken from the experience of the London hospitals.

The antitoxin treatment for diphtheria. In a former chapter (page 12) we learned that when disease germs produce toxin in the body, the body works up an antitoxin to destroy the toxin and save itself from being poisoned. Working in accordance with this principle, scientists have learned how to get a diphtheria antitoxin from the blood of the horse.[2] When a person is at-

[1] In December, 1908, eight cases of diphtheria appeared in Richmond, Virginia, for which there seemed to be no cause. It was soon learned that all these diphtheria patients except one were using milk from the same source, and the farm from which the milk came was investigated. Every one at the farm was in good health, but in the throats of two of the milkers diphtheria germs were found. This incident shows not only how diphtheria may be spread by healthy persons, but also how efficient health officials can help to save people from disease.

[2] The antitoxin is prepared in the following manner: Diphtheria germs are placed in beef broth, where they multiply and produce great amounts

tacked by diphtheria, some of the antitoxin from the horse is injected into the body. This does not kill the diphtheria germs, but destroys their toxin and saves the cells from poisoning until the body can kill out the germs and so stop the disease.

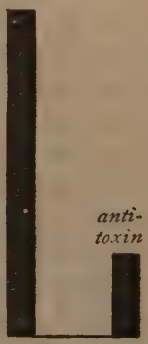


FIG. 30. When no antitoxin is used in the treatment of diphtheria, about forty-four patients in a hundred die. When antitoxin is used, there are only one fourth as many deaths (eleven in a hundred).

It is very important that the antitoxin be given in the early stages of diphtheria, for after the toxin has poisoned the cells of the nervous system, kidneys, and heart, great damage has been done, and it is not possible to undo it. Antitoxin is useful in all stages of the disease, however, and should always be used. It is also very useful in preventing diphtheria, and when a person has been exposed to the germs, a dose of antitoxin is often given to prevent the development of the disease.

The results of the antitoxin treatment. From the very beginning of its use in the treatment of diphtheria, antitoxin has been a great success. Figures from many cities show that when antitoxin is used, only about one fourth as many diphtheria patients die as when it is not

of toxin. A little of this toxin is then injected into the blood of a horse, and the horse begins to work up antitoxin to destroy it. A larger dose of toxin is then given to the horse, and still more antitoxin appears in the blood. More and more of the toxin is injected, until the blood of the horse is made as strong in antitoxin as possible. Then the horse is bled and the blood allowed to clot. The thin yellow liquid (serum) that appears around the clot contains the antitoxin, and it is this liquid that is sealed up in bottles and sold as antitoxin.

used. Indeed, when antitoxin is given in the very early stages of the disease, there are almost no deaths. This is shown by the experience of Richmond, Virginia, in the last four months of 1908. During this time there were 139 cases of diphtheria. Antitoxin was furnished free by the health department of the city, and was freely used. Only one of the 139 cases ended in death, and in this case the child was dying before a doctor was called. It should be understood that the paralysis which sometimes follows diphtheria is not caused by antitoxin, but by the disease. In all cases of diphtheria or in doubtful cases that may prove to be diphtheria, antitoxin should be used at the earliest possible moment.

POINTS TO BE REMEMBERED

1. The diphtheria germ usually grows only in the body, but it may live for some time outside the body.
2. It is transferred from one person to another in many different ways.
3. It is often found in the throat long after the patient has recovered, and is occasionally found in the throats of healthy persons.
4. Every one who is carrying virulent diphtheria germs should be quarantined, whether he is sick or well.
5. The diphtheria germ produces a very powerful toxin that poisons especially the cells of the nervous system, the kidneys, and the heart.
6. By injecting diphtheria toxin into a horse, the blood of the horse can be made very strong in antitoxin.
7. If this antitoxin is used when a person is attacked by diphtheria, it saves the body from being poisoned.

CHAPTER XI

PNEUMONIA

Up to about ten years ago consumption caused more deaths in all parts of our country than any other germ disease. Now a better understanding of how to avoid the germ of consumption, and a better knowledge of how to treat the disease, have considerably lessened the death rate from consumption; and in some of our northern states the pneumonia germ now claims more victims than any other of our microbe enemies. In 1907 it caused nearly 138,000 deaths in the United States. Pneumonia is much more common in cities than it is in the country, probably because in a city, where the people are crowded together, the germ is more easily passed from one person to another, and because fresh air is less abundant in the city than it is in the country.

The character of the disease. Pneumonia usually begins with a chill (often a very severe one), cough, fever, pain in the side, and rapid breathing. The sputum has a rusty color caused by blood from the air sacs of the lungs. The disease runs a swift and severe course, the crisis coming usually in from three to eight days. In rare cases death is caused by the closing of the air sacs in so great a portion of the lungs that the patient cannot breathe, but more commonly the heart is overwhelmed by the toxin that is carried from the diseased lungs by the blood. Pneumonia attacks particularly children under five years of age, aged persons, and

those who for any reason are weak or sick. Users of alcohol are especially liable to pneumonia, and all physicians know that drinkers fare badly when attacked by this disease.

The germ of pneumonia. Pneumonia may be caused by a number of different germs, but 95 per cent of all cases are caused by a small coccus (the *Pneumococcus*). This germ grows not only in the lungs but also in the nose, mouth, throat, and air passages; in children it is a very common cause of inflammation of the middle ear, and it is sometimes the cause of meningitis. The pneumonia germ attacks many animals, and it is possible for man to get the disease from animals.

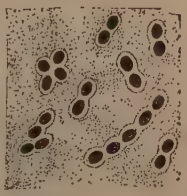


FIG. 31. The pneumonia germ (*Pneumococcus*).

How pneumonia germs enter the body. The sputum of a pneumonia patient is filled with the germs, and they are often in the discharges from the nose. They are spread abroad in about the same ways that diphtheria germs are scattered (page 37). Pneumonia germs can withstand considerable drying, and doubtless they are sometimes inhaled in dust. It is probable, however, that usually they enter the body through the mouth.

Pneumonia germs in the throats of healthy persons. The pneumonia germ is present in the mouths of many, perhaps of most, healthy persons. These germs are real pneumonia germs, and they are capable of causing the disease, as experiments with animals show. Yet they are not nearly so vigorous and powerful in causing the disease as are germs fresh from the lungs of a pneumonia patient, and in an epidemic of pneumonia it

would seem that an especially virulent race of germs had broken loose.[1] It is therefore not advisable to expose one's self to germs from a pneumonia patient, for a person who may be holding in check a race of weak pneumonia germs may very readily fall a victim to a stronger race of the same germs. The sputum and the discharges from the nose of a pneumonia patient should by all means be carefully destroyed.

FIG. 32. Kiss the baby on the cheek, not on the mouth.

Preventing pneumonia by keeping up the health. The pneumonia germ is one of the most widespread of disease germs, and it is not always possible, try as we may, to avoid it. During pneumonia epidemics, therefore, it is advisable to make a special effort to keep up the general health so that the body may be able to kill any pneumonia germs that may reach the lungs. To keep up the health a person should avoid all exposure to wet and should wear sufficient clothing to protect himself from cold. He should avoid alcoholic drinks, for users of alcohol are especially likely to have pneumonia, and the man whose power to resist germs is

[1] In camps where men live in close contact with each other, an exceedingly fatal form of pneumonia sometimes develops. At such times the germ is probably handed on from one pneumonia case to another, and grows in the human lungs until it becomes especially adapted to this kind of home.

lessened by drink falls into the hands of a terrible foe when the pneumonia germ attacks him. A person should also eat good food, take plenty of sleep and exercise, and should spend as much time as possible in the open air. Anything that builds up the general health is a safeguard against pneumonia, and anything that weakens the body may bring on pneumonia. For the germ is already in the mouths and throats of millions of people, waiting for a chance to grow.

The importance of fresh air. There is little doubt that the resistance of the body to pneumonia germs is

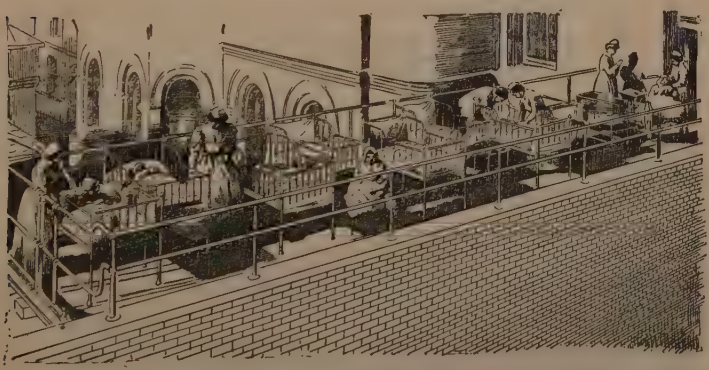


FIG. 33. Pneumonia patients being treated in the open air. (*After photograph of patients in the Presbyterian Hospital, New York.*)

often weakened by a lack of fresh air. By many it is believed that the large number of pneumonia cases in February and March is to be accounted for on the theory that we have been weakened by living indoors all winter, often in houses that are not sufficiently ventilated. Physicians and boards of health are more and

more recommending fresh air as a means of keeping up health, and in treating pneumonia some of the most successful physicians carry the patients outdoors even in the coldest weather, as is done in the treatment of consumption. Any one who wishes to keep up his resistance to the pneumonia germ cannot afford to neglect the fresh air factor.

POINTS TO BE REMEMBERED

1. Pneumonia causes more deaths in our country than any other disease except consumption.
2. It runs a swift course, and death is usually due to toxins that are carried out of the lungs in the blood.
3. Pneumonia may be caused by several different germs, but it is nearly always due to a small coccus (the pneumococcus).
4. This germ may grow in other parts of the body besides the lungs, and attacks animals as well as men.
5. The pneumonia germ enters the body through the mouth and nose.
6. Pneumonia germs are found in the mouths of many healthy people.
7. In epidemics of pneumonia, virulent and especially dangerous races of the germ are abroad.
8. The sputum of pneumonia patients should be destroyed, and pneumonia should be treated as an infectious disease.
9. The pneumonia germ is widespread, and we should keep up the health and the germicidal power of the body to protect us from this disease.
10. Fresh air is one of the greatest factors in building up the resistance of the body to pneumonia.

CHAPTER XII

INFLUENZA, WHOOPING COUGH, AND COLDS

INFLUENZA

Influenza (grip) was little known in the United States until 1889–1890. Then a great epidemic swept over the country, and the disease has been common with us ever since. It is, however, an ancient disease, and epidemics of it were common in Europe in the Middle Ages. It was also common in other parts of the world before its recent introduction into the United States. Usually it causes in the United States about 10,000 or 12,000 deaths a year, and in 1907 it caused over 20,000 deaths.

Fig. 34. The germ of influenza.

The germ of influenza. The germ of influenza is a very small bacillus, one of the smallest disease-producing bacteria known. It grows in the mouth, the throat, the trachea, and bronchial tubes, and occasionally is the cause of pneumonia. Influenza germs linger for a long time, sometimes for more than a year, in the air passages of those who have had the disease, and they are often found in the bronchial tubes of consumptives and of persons who suffer from bronchitis. The germ is in the sputum and in the discharges from the nose, and enters the body through the mouth and nose. The influenza bacillus is easily killed by drying, and in nature it does not grow outside the human body.

Influenza a serious disease. The influenza germ produces a powerful toxin that has a profound effect upon the whole body. It does not poison the body so acutely as does the toxin of the diphtheria germ, but it causes a depression and weakness that often last for months. Another bad feature of the disease is that other troubles, such as pneumonia, consumption, eye and ear diseases, bronchitis, and colds, often follow it, and it may leave a part of the body, as the stomach, the kidneys, or the nervous system, in a weakened condition. Because it is so widespread, because its after-effects are so serious, and because a person may have it again and again, influenza is a much-dreaded disease.

Guarding against influenza. Influenza germs are spread abroad in about the same ways that diphtheria and pneumonia germs are scattered. No attempt is made to quarantine influenza patients, and usually there is great carelessness about disinfecting the sputum. Influenza germs are therefore spread everywhere, and great numbers of persons are attacked by the disease.[1] Every care should be taken to avoid the germs, and the hands, dishes, and handkerchiefs of an influenza patient should be carefully disinfected. Aged persons and persons who are weak should be guarded with especial care from the germs.

FIG. 35. In droplets that are coughed out into the air the germs of influenza, colds, and other respiratory diseases are found (see footnote, page 37).

[1] In January, 1908, more than one third of the people in Chicago were suffering with influenza at one time.

WHOOPING COUGH

Whooping cough is certainly a germ disease, but nothing is known of the germ that causes it. The germs are undoubtedly in the saliva and in the discharges and matter from the nose. The incubation period is usually from four to fourteen days, but it may be as long as three weeks, and the "whoop" may not show itself for some time after the commencement of the disease. Whooping cough is highly infectious from the beginning, and any one who is thought to be taking it should not be allowed to remain in school. As a general rule, a child may be permitted to return to school in six weeks after the beginning of the whoop, provided the severe coughing spells have ceased.

Whooping cough dangerous to children. Whooping cough is not usually supposed to be very dangerous, and often cases of it are not carefully quarantined. As a consequence, it is a widespread disease and causes more deaths than scarlet fever and smallpox combined — more than any of the other common infectious diseases of children. Some persons make no effort to protect their children from whooping cough, or even purposely expose them to it. This is a most pernicious practice, for more than four fifths of all deaths from whooping cough are among children under two years of age. The older a child is, the better he resists the disease, and adults usually either escape it altogether or have a mild attack.

Quarantining in cases of whooping cough. Many persons think that every one must have the more common infectious diseases sooner or later, and often make no attempt to check the spread of these diseases. The

consequence is that some of these rather mild diseases cause many more deaths than other diseases that we regard as much more important. This is especially true of whooping cough, and in this disease quarantine should be enforced with the greatest strictness. It is no more difficult to control whooping cough than it is to control certain other diseases that have been almost stamped out, and there is no reason why it should be allowed to run unchecked.

COLDS

Colds are not well understood, but they are certainly caused by germs that are transferred from one person to another.[1] In no other way can we explain the fact that they run in epidemics.

A *B*

FIG. 36. Germs that are common causes of colds. *A* is the Pneumo-bacillus; *B* is Micrococcus catarrhalis.

The germs that cause colds. During a cold, and indeed at all times, there are great numbers of bacteria growing in the air passages, and it has been very difficult to decide which germ (or germs) causes the trouble. It seems certain, however, that the pneumonia and influenza germs often cause colds, and that the diphtheria germ may do so. It is thought also that a certain bacillus (*Pneumo-bacillus*) which sometimes causes pneumonia is a common (perhaps the most common) cause of colds, and that a small coccus (*Micrococcus catarrhalis*) which is often found in catarrh is sometimes

[1] I have long been satisfied from observation that people often catch cold from one another when shut up in close rooms and coaches, and when sitting near and conversing so as to breathe in each other's transpiration. —BENJAMIN FRANKLIN.

the germ which is causing the trouble in a cold. There are, therefore, a number of germs that can grow in the lining of the nasal chambers and the throat and cause inflammation, and when this happens, we say we have a cold.

FIG. 37. Benjamin Franklin, who was one of the shrewdest men and one of the best scientists of his day. More than a hundred years ago he observed that people catch colds from each other.

Catarrh and bronchitis. Catarrh is a chronic cold, and bronchitis is a cold of the lining of the trachea and bronchial tubes. The small coccus (*Micrococcus catarrhalis*) that is sometimes present in ordinary colds is very frequently found in catarrh, and our old friends, the pneumonia and influenza germs, are common causes of bronchitis. A chronic catarrh is difficult to cure, and the disease should not be allowed to fasten itself on children.

Avoiding the germs that cause colds. A person who is trying to avoid the germs of colds should not borrow pencils, books, or other articles from any one who has a cold; he should not touch soiled handkerchiefs, use public drinking cups, or stand near any one who is coughing without turning away from him; he should keep his hands away from his own mouth and nose, and should frequently wash his hands thoroughly with soap and water (page 161). It is hardly necessary to call your attention to the fact that getting the feet wet, chill-

ing the body, using alcoholic drinks, or doing anything else that lowers the general health, makes us more easy victims of colds. A person who has a cold should

FIG. 38. One way in which the germs of colds and other respiratory diseases may be passed from one person to another.

change handkerchiefs frequently, turn away from others when he coughs, disinfect his hands occasionally, and in other ways try to prevent the spread of the germs.

POINTS TO BE REMEMBERED

1. Influenza is caused by a small bacillus that is passed from one person to another in ways that do not allow it to dry.
2. Influenza is a serious disease, and the germs should be avoided as much as possible.
3. Whooping cough is a serious disease, and should be quarantined.
4. Colds, catarrh, and bronchitis are caused by germs growing in the air passages and throat.
5. These diseases are infectious, and care should be taken to prevent the spread of the germs.

CHAPTER XIII

TUBERCULOSIS

PROBABLY from the earliest times, mankind has been afflicted with tuberculosis, for a great Greek physician named Hippocrates wrote a treatise on consumption in 400 B.C., and in the lungs of Egyptian mummies the marks of consumption have been found. At the present time *Bacillus tuberculosis*, or the *tubercle bacillus*, as it is sometimes called, is the most deadly of all the bacterial enemies of man. In our own country, more than one tenth of all deaths are caused by this germ, which means that the "Captain of the Men of Death" is killing our fellow-countrymen at the rate of 150,000 a year, over 400 a day, and one every three and a half minutes. Years ago Oliver Wendell Holmes called consumption the Great White Plague, and it richly deserves the name.

The cost of tuberculosis. Because tuberculosis selects its victims especially from those who are in the active working years of their lives,[1] and because it is a lingering illness, it costs us far more in money than does any other disease. It is difficult to calculate the cost of sickness in dollars and cents, but one estimate that has been widely accepted places the cost of tuberculosis to our country at a billion dollars a year. Just how great a sum this is you will realize better when you know that it is more than two fifths as much as the yearly wages of all the factory workers in the United States, nearly

[1] One third of all deaths between the ages of fifteen and forty-five are from tuberculosis.

three times as much as the whole country spends on its public and high schools, and twenty times as much as it spends on its colleges and universities. Yet the death rate from tuberculosis has fallen amazingly in the last thirty years, and it would be a simple matter to prevent nearly all cases of the disease.

The germ of tuberculosis. The germ of tuberculosis is a slender bacillus. It is a slow-growing bacterium, but it is a very hardy one, and often it resists all attempts of the body to kill it and grows steadily on until it causes death. Outside the bodies of men and animals it does not grow at all in nature, and light and drying kill it. Yet in a dark, damp house the germs in the sputum of a consumptive may live for several months or perhaps for a whole year. Away from the habitations of men and animals the tubercle bacillus is not found, but it is often present in the earth and dust about places where cattle are kept, and in dust in the rooms of careless consumptives.

FIG. 39. The bacillus of tuberculosis.

Different forms of tuberculosis. The tubercle bacillus may grow in almost any part of the body and cause tuberculosis of the part attacked. Tuberculosis of the lungs, or consumption, is the best-known form of the disease, and causes by far the most deaths. Tuberculosis of the bones is also a common trouble, and most of the lame and crippled people that we see have been deformed by tuberculosis of the spinal column, or of the bones of the hips, legs, or feet. Tuberculosis of the bones is especially common among children, as is also scrofula, or tuberculosis of the lymphatic glands. Tuberculous meningitis, which causes more deaths than any other form of tuber-

culosis except consumption, is more common among children than among older persons. The skin, kidneys, intestine, larynx, and other parts of the body also may

FIG. 40. Nearly all the lame and crippled people that we see have been deformed by tuberculosis of the bones.

be attacked by this germ; and when the tubercle bacillus is growing anywhere in the body, it is always possible for it to be carried by the blood to the lungs.

How the tuberculosis germs enter the body. It is not possible in most cases of tuberculosis to tell how the germ got into the body. There is no doubt, however, that many cases come from breathing in germs from dust, dried sputum, and droplets that have been coughed out by consumptives, and that many other cases come from germs that have been swallowed and that have passed through the walls of the intestine into the blood. It is probable that the germ gets into the body by way of the mouth more commonly than was formerly supposed.

How tuberculosis germs are scattered. The form of tuberculosis that is most dangerous to those about the

patient is consumption. In this disease, the germs may be coughed out into the air in droplets of saliva, they may be carried by flies if all sputum is not carefully destroyed at once, and they may be spread abroad in all the ways that pneumonia and diphtheria germs are scattered (page 37). Dishes that have been used by a consumptive are a source of danger unless they are disinfected, and food that a consumptive has prepared or touched may contain the germs. The tuberculosis germs may also be blown about in dust, they may be carried on the feet from sidewalks and other places where people spit, and in almost countless ways these germs can reach the mouth and nose; for they can withstand long drying, and in dust and dried sputum they remain alive and virulent after the germs of many other common diseases would be dead. The greatest danger of all comes from the habit of spitting that some careless consumptives have, for in the advanced stages of the disease several billion germs are thrown off daily from the lungs. Indeed, it is not right for any one to spit in public places, for it is probable that more than one half of the people in our country who have consumption, do not know that they are afflicted with the disease.

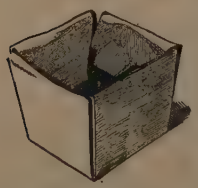


FIG. 41. A waterproof pasteboard sputum cup. These are very cheap and they should be burned after being used.

Disinfecting sputum. The importance of destroying the sputum of consumptives cannot be too strongly insisted on. It should be received either in pasteboard cups that can be burned, or in a vessel that contains a disinfectant. Carbolic acid is a good disinfectant to use for this purpose, but lysol is better,

for it dissolves the mucus of the sputum and allows the disinfectant to get quickly to the germs (page 160). When the consumptive is traveling, the sputum may be received in waterproof envelopes or pocket sputum cups that are made for the purpose, or on pieces of cloth that may be carried in a paper bag until a fire is reached. The sputum should not be swallowed, for if this is done, the germs may set up intestinal tuberculosis, or they may pass through the intestinal wall, be carried away in the blood, and start the disease in some part of the body that has not yet become infected. Under no circumstances should the sputum be allowed to dry, for in the dry condition it is impossible to keep the germs from being scattered about.

FIG. 42. A pocket sputum cup, to be burned after being used.

Other precautions to be taken. A consumptive should hold a paper napkin or a handkerchief before his face when he coughs, and these napkins or handkerchiefs should be burned, or placed in a disinfectant, or kept in water until they can be boiled. A consumptive should learn to keep his hands away from his face and mouth, and should occasionally wash his hands in a disinfectant. He should have his own dishes, and these should never be washed with other dishes, nor allowed to come in contact with them until after being boiled for at least five minutes. His bedclothes, clothing, and furniture ought occasionally to be disinfected, or at least exposed to the bright sunshine as much as possible, and his clothing should be boiled before it is washed

with other clothes. A consumptive should have a sleeping room to himself, and this room should be kept bright and well ventilated, to help kill any germs that may be free in it. A house in which a consumptive has lived should be disinfected before any one else moves into it.

Danger from a consumptive. If he is careful, a consumptive can live with his family with little danger to those about him; but if he is careless and scatters about the millions of germs that come from his lungs, he is a real source of danger to all who come in contact with him. Many persons have a great fear of all consumptives, but this is unreasonable, for it is only the careless consumptive that is to be feared.

FIG. 43. This house stands at the edge of a small village. Sunshine and pure country air are abundant about it, but the house is infected with tuberculosis germs. Three different families have lived in it during the last six years, and each of these families has had one or more members stricken with consumption while living in the house.

Alcoholism and tuberculosis. In a former chapter (page 15) it was stated that alcohol lessens the power of the body to kill germs and that the death rate from consumption is much higher among brewers than among ministers. We should like at this time to call your attention again to the fact that the person who uses alcohol makes himself more liable to tuberculosis. In the sanatoria for consumptives in Loslau, Germany, in 1899, 94 per cent of the patients were drinkers and only 6 per cent were abstainers. So closely connected are the use of alcoholic drinks and tuberculosis that in Paris,

in 1905, the International Tuberculosis Congress adopted the following resolution: "*We strongly emphasize the necessity and importance of combining the fight against tuberculosis with the struggle against alcoholism.*"

TUBERCULOSIS IN ANIMALS

The tubercle bacilli of cold-blooded animals and of birds do not seem to be able to attack man. Practically every one who has studied the subject, however, believes that the tubercle bacillus of cattle and of the hog can grow in the human body. Sometimes we get these germs into our bodies from meats, but there is far more danger of getting them from milk.

Tubercle bacilli in milk. From 15 to 30 per cent of dairy cattle have tuberculosis, and about 10 per cent of ordinary city milk contains living tubercle bacilli. A considerable amount of butter contains the germs, which have been found alive in butter at the end of three months.

There is no doubt that the germs in butter and milk can cause tuberculosis in man, and it now seems certain that many children become infected with tubercle bacilli from milk. Yet the germs that are in milk are fitted for growth in the body of the cow and not in the human body, and probably are not nearly so dangerous to us as are germs from human sputum. One reason for believing this is that among the Filipinos, the Japanese, the Alaska Indians, and other peoples who use practically no milk and butter, tuberculosis is about as common as in other countries. Another reason for this belief is that if the tubercle bacilli in milk were very virulent for man, all of us would probably have been dead of tuberculosis long ago.

Still, these germs are dangerous and no one wants to be eating and drinking them from day to day. All dairy cattle should be examined, therefore, to see if they are free from the disease. A very simple and certain method of doing this has been discovered, and even if there were no danger of man's getting the disease from cattle, tuberculous cattle should be separated from those that are free from the disease. This is economy, for by taking out of a herd all the animals that have tuberculosis, the spread of the disease in the herd can be stopped.

POINTS TO BE REMEMBERED

1. Tuberculosis costs the United States 150,000 citizens each year, and it is estimated that its annual cost in money is $1,000,000,000.
2. The tubercle bacillus is slow-growing, but it is very difficult to kill.
3. In tuberculosis any part of the body may be attacked, but consumption is by far the worst form of the disease.
4. The germs enter the body either by being inhaled or by being swallowed.
5. They withstand drying and are scattered in many ways.
6. The sputum of consumptives is full of germs, and it should be burned or disinfected.
7. A careless consumptive is dangerous, but a careful consumptive is not to be feared.
8. The tubercle bacilli that are often present in milk are dangerous to man.

CHAPTER XIV

THE TREATMENT OF CONSUMPTION

The steady manner in which consumption often runs on and on has caused many persons to think that it is an incurable disease. This is a great mistake. The Germans say that "every one is a little bit tuberculous," and this is almost the truth. The bodies of five hundred persons who died from diseases other than tuberculosis were examined, and in all but fifteen of them tubercle bacilli were found in some part of the body. Even in the lungs of most grown persons there are scars showing where tubercle bacilli have started to grow and have been checked. It is a very common occurrence for the tubercle bacillus to start its growth in the lungs and to be checked by the body without the person who is being attacked ever knowing what is happening. If consumption is taken in hand before the germs have gained a secure foothold, it yields to treatment much more readily than many other bacterial diseases.

The importance of early treatment. In the treatment of consumption, everything depends on beginning in the early stages of the disease (Fig. 44). One who has symptoms[1] of consumption, therefore, should not try to persuade himself that his symptoms have no existence,

[1] The most common symptoms of consumption are cough, loss of appetite, gradual loss of weight and strength, fever in the afternoon, night sweats, and blood spitting. The cough may be absent in the very early stages of the disease, or it may be troublesome only in the early morning and after going to bed at night.

for this will not stop the growth of the germs. He should not lose valuable time experimenting with patent medicines, for there is no medicine known that will cure consumption. The only sensible thing for him to do is to be examined at once by a physician who thoroughly understands the disease. Then, if he finds that the

FIG. 44. The amounts of white in *A*, *B*, and *C* show the chances that a consumptive in the early, moderately advanced, and advanced stages of the disease has of being cured or of having his disease arrested. These figures are from the experience of the State Sanatorium at Rutland, Massachusetts. From 1889–1907 this institution treated 1911 persons who were in the early stages of consumption, and in 1450 of them the disease was apparently cured or arrested. Of moderately advanced cases 1616 were treated, and in 604 of them the disease was apparently cured or arrested. Of more advanced cases 784 were treated, and in only 147 was the disease apparently cured or its progress stopped. These figures show the very great importance of early treatment of the disease.

germs have gained a foothold in his lungs, he should give himself the best possible treatment without delay.

Important factors in treatment. In the successful treatment of consumption, the following are the more important factors: —

Rest. If a consumptive can be kept quiet, much of the toxin that is produced by the germs will be thrown off in the sputum. Anything that causes the breathing to be quickened and deepened causes more of the toxin to be carried from the lungs through the body, and increases the fever.

A consumptive should therefore have rest. If he has fever, he should have absolute rest, not even walking about his room. Laughing and loud talking should be avoided, and coughing should be refrained from as much as possible. When there is no fever, a little exercise may be taken, but it should be taken with care.

Food. A consumptive should have an abundance of nourishing food, especially of fatty food. Meat, eggs, milk, and any other good foods that he can eat and digest should be taken. Lunches should be eaten between meals and on retiring. The foods must be well prepared and served in different ways, or the patient will become tired of them. "Stuffing" a patient, however, may cause indigestion, and the diet of a consumptive should be looked after carefully.

FIG. 45. An outdoor sleeping place, of a kind that most consumptives can have.

Outdoor life. Nothing in the treatment of consumption is more important than fresh air, and the disease has been most successfully treated when the patients have lived and slept in the open air, summer and winter. Often an upper porch can be arranged as a sleeping place. In outdoor sleeping in winter, it is necessary to have warm clothing and to wear some kind of hood to protect the head and neck, and in many places in summer it is necessary to screen the patient from mosquitoes.

Other important points. Warm and dry clothing is of course important. If a consumptive lives indoors he should be sure, above all else, to have plenty of fresh air. Consumption is much more frequent in damp houses and on wet soils than it is in dry houses and on sandy soils.

FIG. 46. Consumptives taking the winter air on a city roof.

A consumptive should not remain in a damp house, and if he lives outdoors, it should be on a dry soil.

Finally, every consumptive should have a skilled physician to watch over and guide him in his treatment of himself, and he should secure some of the many books and circulars that have been written on consumption and its treatment, and learn how to live in a way that will

give the best possible chance for recovery.[1] He should always think of the safety of others and should take care

FIG. 47. Window tents can be bought that allow a consumptive to obtain fresh air through an open window while his body remains in bed in a warm room. This tent was designed by Dr. S. A. Knopf.

not to endanger those about him. He should be cheerful and hopeful, for if he takes his disease in time he has every reason to expect recovery.

The effect of climate on consumption. It was formerly supposed that climate was very important in the treatment of consumption, but in all our states consumptives

[1] A splendid little book on consumption, written by Dr. S. A. Knopf, is sold by *The Survey*, 105 East 22d Street, New York, and 628 Unity Building, Chicago, for 25 cents in paper or 50 cents in cloth. Many state and city boards of health publish very valuable bulletins and circulars that are distributed free to any one writing for them, and a consumptive can easily learn where other books on the subject may be bought.

are now being cured, and it has been found in treating this disease that rest, food, and fresh air are of much more importance than climate. Unless a consumptive has money enough to support himself without work and to give himself proper care, he should not leave his home for a distant state. For in many places consumptives are not welcomed, and it is better to be at home and have the proper care than to be without money or friends in the best climate in the world. In general, a cold, dry climate is best for consumptives, and they should avoid hot climates and high elevations.

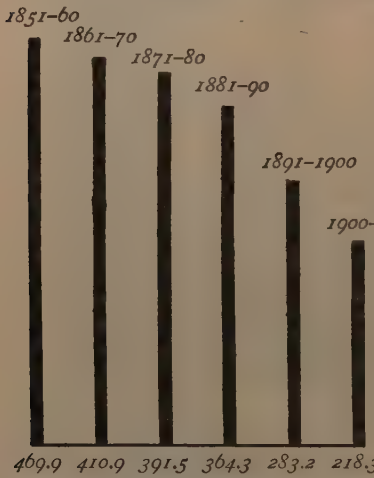


FIG. 48. Diagram showing the decrease in the death rate from tuberculosis in Massachusetts since 1851. The figures at the foot of each column show the number of deaths a year for each 100,000 inhabitants.

Sanatoria for consumptives. Many states have established sanatoria to which consumptives can go and, at a slight expense, remain until they recover from the disease. This is sensible, for in a sanatorium a consumptive can have proper food and care at much less expense than he can have them at home, and the physicians in the sanatorium know how to disinfect so that there is no danger of the spread of the disease. It is much more economical for the people of a state to care for their consumptives in sanatoria than out of

them, and it is much pleasanter and better for the patients. In checking the spread of tuberculosis, sanatoria have been a wonderful help — perhaps a greater help than any other one thing.

Inheritance and consumption. Consumption is often spoken of as an inherited disease, and it is true that some families are more afflicted by it than are other families. This does not mean that children in these families are born with tuberculosis germs in their bodies, but it means that they are born with less power of killing these germs than most people have. *People who come of consumptive families cannot have consumption unless they get tubercle bacilli into their lungs,*[1] and if they can avoid the germ, they may be as well and strong as any one. It should be understood that persons who move into houses that are infected with tubercle bacilli often contract the disease, although there

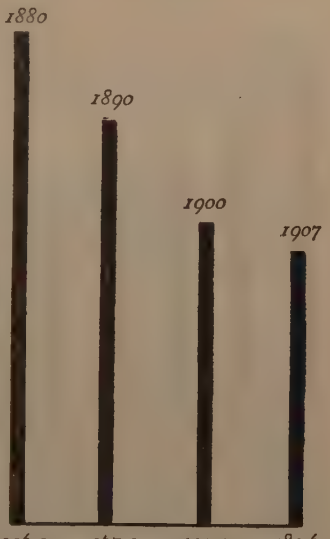


FIG. 49. This diagram shows the gradual decrease in the number of deaths from tuberculosis in the United States. The numbers given are the deaths per 100,000 in the part of the United States where statistics have been carefully kept.

[1] A tendency to consumption may be inherited, just as a tendency to drunkenness may be inherited. But without whisky or other alcoholic drinks we can have no drunkenness, and without the tuberculosis germ we can have no consumption. — DR. ENNION G. WILLIAMS.

may be no history of consumption in their families. It is true also that those who have married consumptives or who have lived in houses with them die of the disease almost as often as do the brothers and sisters or the children of consumptives.

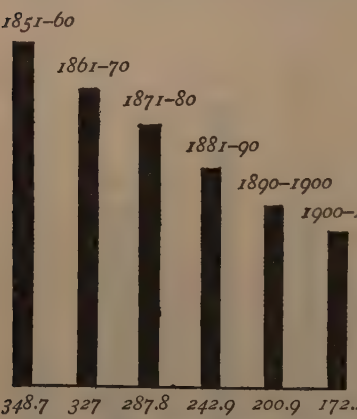


FIG. 50. This diagram shows the decrease in deaths from tuberculosis in England and Wales.

These facts show that when several members of a family die of consumption, the trouble is not so much a matter of inheritance as that the healthy members of the family get the germ from those who are sick. A person who is of a consumptive family should therefore not worry about the disease being inherited, but should try to keep himself from being exposed to the germs; he should be careful about pneumonia, grip, measles, colds, and other diseases that weaken the body so that the tuberculosis germs are able to attack it successfully; he should avoid alcohol and other things that will injure his body, and try to lead a healthful life. Above all he should make sure that he secures an abundance of that great upbuilder of the body, *fresh air.*

Progress in the prevention of tuberculosis. As we have seen, no germ has so spread itself through all society and has so extended its ravages to all parts of the

world as has the tubercle bacillus. Yet the world is not full of tubercle bacilli. The air of the fields and woods,

FIG. 51. Tent sanatorium for consumptives of the Modern Woodmen of America, at Colorado Springs, Colorado. (*After a photograph.*)

the streams of the forests and mountains, and the soil of the fields, are free from them. The millions of people who in the past have died of tuberculosis germs got these germs from either sick cattle or sick men. Practically all the millions of people now living who are carrying these germs in their bodies were infected either by human sputum or by milk. Some persons, some cities, some states, and some nations have to a greater or less degree known these facts for some years, and in some places a warfare against the Great Plague has been started. This warfare has been most successful. Examine Figure 48 and you will see that not half so many people are now dying of tuberculosis in Massachusetts as died of it in that state a half century ago. Examine Figure 49 and you will see that what is true of Massa-

chusetts is true also, to a great extent, of other parts of the United States; and Figure 50 shows that not only in our own country but also in other countries has this great enemy of mankind been checked. "Tuberculosis is communicable, preventable, and curable," is the battle cry of the anti-tuberculosis host, and in that host hope swells high in every breast, for already in many places the battle line of the enemy has been broken, and his forces are being driven back. Much of the work that is being done has as yet hardly begun to show its effect, but the results prove clearly that it is not necessary for people to die of tuberculosis as they are dying now.

POINTS TO BE REMEMBERED

1. In its early stages consumption is curable.
2. Rest, food, and fresh air are the important factors in the treatment of the disease.
3. Climate is not so important in the treatment of tuberculosis as was formerly supposed.
4. Sanatoria are to be recommended because in them the patient can have the care that he needs, and in them there is no danger of the spread of the disease.
5. The germ of tuberculosis is not inherited, but some persons do inherit only a slight resistance to the germ.
6. A person who belongs to a consumptive family should take especial care to avoid the germ and to keep up his health.
7. Great progress has been made in the war against tuberculosis, and those who are fighting the disease are very hopeful for the future.

CHAPTER XV

DISEASE GERMS IN DUST

In a cubic yard of ordinary air there are from a hundred to a thousand bacteria. These bacteria are clinging to particles of floating matter of one kind and another, for they themselves are heavier than air, and by themselves would fall to the earth like little stones. Air that is free from dust is therefore free from germs also, and by stirring up dust the number of germs in the air can be increased to multitudes. Most of the bacteria that are in the air are harmless, but sometimes disease germs are clinging to particles of floating matter or flying dust. How very abundant small floating particles are in the air of houses may be seen when a ray of sunshine enters a darkened room through a narrow opening. We shall now discuss the question of disease germs in dust, because in the main the diseases that are spread by dust are respiratory diseases.

The disease germs that are in dust. Occasionally the germs of diphtheria, pneumonia, and catarrh may be in dust, but by far the most common of the dust-carried germs is the tubercle bacillus. The germs of smallpox and scarlet fever may also be dried and blown about, and measles, and possibly whooping cough, can be contracted from the air.

How germs get into the air. Dust from the house of a careless consumptive contains the bacillus of tuberculosis. Dust from houses that have not been lived in by consumptives does not contain this germ. Practically all

the disease germs that are in the dust, except the germ of tetanus and its relatives, *have been spit into it by human beings.*

If you will count up the disease germs that may be in the saliva (the germs of consumption, pneumonia, influenza,

FIG. 52. It is easy to keep this kind of room light, well ventilated, and free from dust.

catarrh, meningitis, scarlet fever, measles, and plague), you will see that for the sake of others every one should cease to spit in buildings or on sidewalks or streets. Handkerchiefs are another source of danger, and they should be changed frequently, especially when one has a cold or other disease of the air passages. For if sputum, or mucus from the nose, is allowed to dry on a handkerchief in the pocket, a shower of finely powdered, germ-laden particles will be scattered abroad in the air when the handkerchief is again flourished.

Keeping down dust. While everything possible should be done to keep disease germs from getting into dust, yet we cannot, at present, keep dust free from germs. Dust is therefore a carrier of disease, and

we should use every possible means to keep it down. Streets should be cleaned and sprinkled, houses should be swept with carpet sweepers or damp brooms, and some damp material should be used in sweeping schoolrooms and other public buildings.[1] Schoolrooms should be swept after school, so that there will be time for the dust to settle before the pupils assemble the next morning, and other public buildings should be swept some time before they are to be used. Dusting should be done with a damp cloth that will wipe off the dust and take it away, for it is foolish simply to stir up the dust into the air, where it will be inhaled or will settle again on objects in the room. In rooms that are much used, hard floors, rugs, and plain furniture are more hygienic than heavy carpets and plush-covered furniture, because it is easier to keep them free from dust. Vacuum cleaners are recommended by health officials, because they

FIG. 53. The wrong way to remove dust from furniture.

[1] The Michigan State Board of Health recommends the following for use in sweeping the floors of public buildings: —

(1) To a pailful of sawdust wet with hot or cold water add one half pint of kerosene and a tablespoonful of sulpho-naphthol or formaldehyde.

(2) Heat one third part sand, and add two thirds part sawdust. To a pailful of this mixture add one half pint of paraffin oil (kerosene may be used) and mix thoroughly. This preparation produces excellent results.

(3) Boil one pound of salsoda and one pound of chlorid of lime (bleaching powder) in a gallon of water. Dampen sawdust to be used for sweeping with this solution. This preparation is excellent for restoring the natural color of floors.

remove dust and do not stir it up where it will be breathed into the lungs.

An additional reason for keeping down dust. Besides the evil that they do by carrying germs, dust particles are themselves irritating to the linings of the eyelids and air passages, and by wounding the delicate surfaces of these parts allow germs (especially pus-forming bacteria) to get in and start their growth. Where dust is continually blowing about in the air, sore eyes and sore throats are especially frequent. Dusty trades are exceedingly unhealthful, and men who work at certain occupations (as, for example, the grinding of metals) have the linings of their air passages so wounded by sharp particles that respiratory diseases (especially consumption) claim most of them. The use of streams of water in metal grinding and stone cutting, and of air blasts in cotton weaving and other dusty trades, would save many of the workers from death by diseases of the air passages and lungs.

POINTS TO BE REMEMBERED

1. Germs are in the air only when floating matter or dust is in the air.
2. Respiratory diseases, especially consumption, are the ones most frequently contracted from the air.
3. Most of the disease germs that are in the air have come from the sputum of human beings.
4. Every possible effort should be made to keep down dust.
5. Flying dust not only carries germs, but makes wounds in the linings of the eyelids and of the mouth and air passages, where germs start their growth.
6. Water or air blasts should be used to keep down the dust in some trades.

CHAPTER XVI

THE ALIMENTARY CANAL

The alimentary canal is a long passageway through the body. Its principal divisions are the mouth, throat, esophagus, stomach, small intestine, and large intestine. Like the air passages, the alimentary canal has warm, moist walls that afford a good place for the growth of germs. The juices of the stomach contain an acid that keeps most bacteria from growing in that part of the alimentary canal, but in the long reaches of the small intestine a number of germs grow and cause disease.

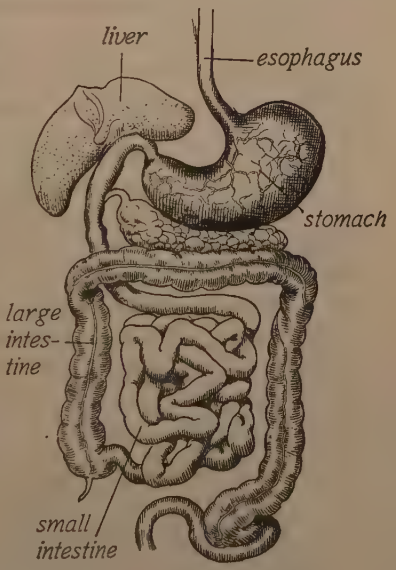


FIG. 54. The alimentary canal.

Bacterial diseases of the intestine. Among bacterial diseases of the intestine are typhoid fever, cholera, dysentery, diarrhœa, and meat poisoning. This group of diseases causes yearly in the United States about 135,000 deaths, or more than one tenth of all the deaths that occur; and of these 135,000 deaths about 85,000

are among children under two years of age. It should be understood that intestinal diseases are much more easily prevented than are respiratory diseases, for the germs of nearly all of them die when thoroughly dried, and the mouth is the one point that needs to be guarded to keep these germs out of the body. Another point that should be noted is that intestinal diseases are most to be dreaded in the warmer parts of the earth, while certain respiratory diseases (pneumonia, influenza, diphtheria) flourish best in the colder regions.

POINTS TO BE REMEMBERED

1. The alimentary canal is a long tube through the body.
2. In some parts of the alimentary canal, especially in the mouth, throat, and intestine, bacteria grow abundantly.
3. Intestinal diseases cause 135,000 deaths in the United States each year.
4. These diseases attack children especially.
5. The germs of intestinal diseases enter the body through the mouth.

CHAPTER XVII

TYPHOID FEVER

TYPHOID fever is found in all climates and in all countries where man dwells. It is usually a severe disease, but during some cases ("walking typhoid") the patient is hardly ill enough to go to bed. In the last census year (1900) typhoid fever caused 35,000 deaths in the United States. The incubation period is from seven to twenty-one days.

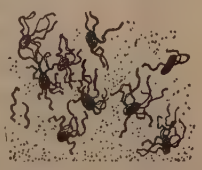


FIG. 55. The typhoid germ.

Typhoid fever an important disease. The importance of typhoid fever is not shown by the number of deaths that it causes. For every person who dies from typhoid fever there are six or seven others who must be watched over through the anxious weeks of an attack, and of these a considerable number rise from their sickness with weakened kidneys, lame backs, crippled limbs, or other injuries that last through life. There are at least 200,000 cases of this disease in the United States each year.

The typhoid germ. The germ of typhoid fever is a plump bacillus. It is fitted to live in a liquid, and swims freely. It enters the body through the mouth and attacks especially the walls of the small intestine, but in cases of typhoid the germ is found in the blood and all through the body. Meningitis, pneumonia, and ulcers in the bones are caused by this germ, and the "rose spots" that appear on the abdomen in most cases

of typhoid fever are caused by the germs growing in the skin. The germs leave the body in the discharges from the bowels and kidneys,[1] and occasionally in matter vomited by a typhoid patient. They may be in the perspiration, and if they are growing in the lungs, they will be found in the sputum.

Pittsburg

The typhoid germ outside the body. The typhoid germ is not known to attack animals. It can live in water for several weeks, and in the soil it is thought that it lives for several months. It multiplies rapidly in milk. Drying quickly kills it, and in general, typhoid germs usually die soon after they leave the human body. Typhoid victims are therefore persons who have taken into their mouths germs that not long before left the body of some one else.

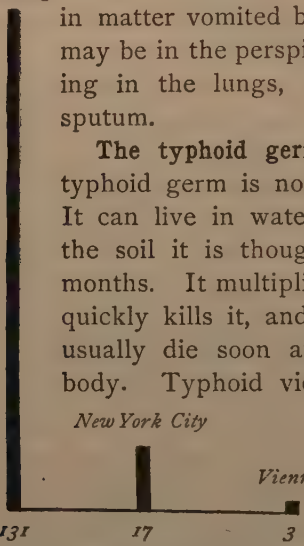


FIG. 56. Diagram showing the number of deaths from typhoid fever for each 100,000 inhabitants in Pittsburg, New York, and Vienna in 1907. At that time the people of Pittsburg were drinking the polluted Ohio River water, New York had a good water supply, and Vienna secured its water from the melting snows on the mountains.

How typhoid fever is contracted. Persons in the same house with a typhoid patient may get the germ on their hands by handling bedding or in a hundred other ways. Flies will carry the germs in great numbers if all wastes from a typhoid patient are not carefully destroyed.

[1] In about 25 per cent of typhoid cases, the germs are in the urine, sometimes in enormous numbers (100,000,000 to 500,000,000 in a cubic centimeter, or 5,000,000 to 25,000,000 in a single drop). This must be carefully disinfected, or it will prove a most dangerous source of infection.

Occasionally the germs are in oysters that have been grown in polluted waters, and for this reason cooked oysters are safer than raw ones. In a large number of cases, the typhoid germ has been carried in milk where some one having the disease has handled the milk, or where the milk vessels have been washed in water containing the germs.[1] In many other cases typhoid is contracted from water. In a later chapter we shall discuss the subject of disease germs in drinking water (page 86).

FIG. 57. In 1895 Chicago ran its sewage into Lake Michigan, from which its water supply was obtained. A new drainage canal now carries most of the sewage away from the lake. The diagram shows the decrease in the number of deaths from typhoid, following the improvement of the water supply.

Germ carriers. It has been found that a considerable number of persons who have typhoid carry the germs long after recovery from the disease. The germs usually locate themselves in the gall bladder and keep on passing into the intestine. One cook in New York gave the disease to twenty-seven persons in five years; a cook in Richmond, Virginia, gave the disease to ten persons in four widely separated houses. In one case the germs were found in the discharges from the body forty-two years after recovery from the dis-

[1] In 1907 a case of typhoid fever occurred in a mountain house near Palo Alto, California. The wastes from the patient were thrown into a stream on which a dairy was located some distance below. The milk cans at the dairy were washed in the stream, and a typhoid epidemic of 236 cases developed among the people who were supplied with this milk. In the spring of 1908 one milkman in Boston who was suffering with typhoid caused an epidemic of over 400 cases.

ease. As yet it has not been possible to free these persons from the germs, and they are a constant source of danger to all about them.

The prevention of typhoid fever. Typhoid fever is one of the most easily prevented of all diseases. The great preventives of it are pure drinking water, a safe method of disposing of human sewage, destroying carefully the germs that come from the bodies of typhoid fever patients and others who are carrying typhoid germs, and removing the breeding places of flies. In later chapters these questions will be discussed.

POINTS TO BE REMEMBERED

1. There are annually at least 200,000 cases of typhoid fever in the United States.
2. All cases of typhoid are caused by germs that have come from the human body.
3. The germs enter the body through the mouth, most frequently in water.
4. Some persons carry the germs long after they have recovered from the disease.
5. Pure drinking water, proper disposal of sewage, destroying all wastes that contain typhoid germs, and the removal of the breeding places of flies are the great factors in the prevention of typhoid.

CHAPTER XVIII

DISEASES CAUSED BY RELATIVES OF THE TYPHOID GERM

THE causes of some of the germ diseases of the intestine are not well understood, as so many different bacteria are found growing in the intestine that it is sometimes impossible to be sure which one is causing trouble. Among the germs frequently found in the intestine are several that are closely related to the typhoid bacillus. In this chapter we shall study some of the more important and best-known of these germs.

The colon bacillus. The colon bacillus is very much like the typhoid bacillus. It is always found in the intestine of man and of all the higher animals. Usually it feeds on the contents of the intestines and does no harm, but when the body is weakened (as by hot weather), or perhaps when a more powerful race of the germs gets into the intestine, the colon bacillus seems to be a cause of diarrhœa and other troubles.

The bacillus of dysentery. Chronic dysentery is caused by a protozoön, and we shall study this disease in a later chapter (page 131). The sudden attacks of acute dysentery, which sometimes run in epidemics, are caused by a bacillus that differs very little from the typhoid bacillus.[1] This is a severe disease, and one that is greatly feared by armies. In different parts of the United States there are epidemics of it every summer. The germs are scattered in the same ways that typhoid germs are

[1] Acute dysentery is often called *flux*.

scattered, and because the disease is a very dangerous one, all matter from a dysentery patient should be carefully destroyed.

Meat poisoning. Meat poisoning (often called *ptomaine* poisoning) is caused by two different germs. The most common form of the disease is caused by a bacillus of the typhoid group that attacks cattle, horses, hogs, and goats. The germ is in the flesh before the animals are killed, and in a few cases epidemics of the disease have been caused by unprincipled butchers who killed sick animals and sold the flesh. Meat infected with this germ does not differ in appearance or taste from wholesome meat.

The other form of meat poisoning is caused by a bacillus that is a relative of the germ of tetanus. It gets into the meat after the animal is killed, and meat containing this germ usually has a bad odor. This bacillus does not grow in the human body, but in its growth in meat it produces a toxin which violently poisons the body. Thorough cooking will destroy the toxin, and meat poisoning of this kind is usually caused by sausages that are bought and eaten without further cooking. This germ gets into meat from dirt, and meat that is to be used as food should be handled in a cleanly manner.

POINTS TO BE REMEMBERED

1. The colon bacillus is always found in the intestine, and at times probably causes mild forms of disease.
2. Acute dysentery is caused by a bacillus that resembles the typhoid germ in appearance and in the way it is spread.
3. Meat poisoning is due to bacteria that are found in the flesh of diseased animals, or that get into meat from unclean handling.

CHAPTER XIX

OTHER BACTERIAL DISEASES OF THE INTESTINES

DIARRHŒA and inflammation of the intestine are important causes of death, especially among young children. All together these troubles cause in our country over a

FIG. 58. In the federal armies, during the four years of the Civil War, 110,070 soldiers were killed in action or fatally wounded. During the four years from 1903–1907, in the United States, 271,773 children under two years of age died from diarrhœa and other similar diseases. The height of the child and the height of the soldier show the relative number of deaths in each case.

hundred thousand deaths a year. They are most to be feared in the summer, the time when children are weakened by the heat, and the time when germs multiply most rapidly in water and in foods. The germs enter the

body in water, milk, and other foods. Flies are especially responsible for the spread of these diseases.

Germs that cause diarrhœa. It seems probable that any one of several different kinds of bacteria may cause diarrhœa and inflammation of the intestine. In some cases pus-forming bacteria (sometimes streptococcus, sometimes Bacillus pyocyaneus) seem to be the guilty germs. In other cases it is probably the colon bacillus. Probably mild attacks of typhoid fever and dysentery are sometimes mistaken for simple diarrhœa. The disease is infectious, and germs from a sick person should be destroyed.

Weak and strong races of intestinal germs. It is probable that among the germs that commonly grow in the intestine there are different races, some more powerful than others. It is also probable that new races of these germs give us more trouble than those to which we are accustomed; for water that does not seem to trouble those who use it daily will often start intestinal disturbances in visitors and travelers. This is probably because those who drink the water from day to day become accustomed to the germs in it and their systems learn to resist them, while a stranger is not prepared to overcome germs of these particular races.

Cholera infantum, or summer complaint in children. It has not been possible to prove that any one germ is the cause of cholera infantum. In a number of epidemics the bacillus of dysentery has been discovered, but in many cases other germs seem to be the cause. The trouble seems to be that in summer babies are weakened by the heat until they have little resistance to germs, and at the same time the milk which is fed to babies is

kept warm until it swarms with multitudes of bacteria of many different kinds. *To prevent cholera infantum the milk must be kept clean and cold,* and it should be used as fresh as possible. The milk vessels and the bottles should be thoroughly washed and scalded to kill germs that are on them, and no impure water that is likely to contain germs capable of causing diarrhœa should ever be given to a little child.

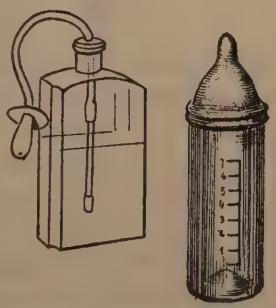


FIG. 59. The wrong kind of nursing bottle and the right kind. The bottle with the long, slender tube and the narrow mouth is hard to keep clean; the bottle with the wide mouth may be cleansed easily.

Indigestible foods that will lie in the intestine and form a breeding place for germs should not be given to young children. Children should be given all the fresh air possible, and their general health should be built up in every way, so that they will be able to resist germs. It should be remembered that cholera infantum is infectious, and any person who is caring for a little baby should keep the baby away from where the disease is.

POINTS TO BE REMEMBERED

1. Diarrhœas are caused by several different germs.
2. It is probable that there are weak and strong races of these germs.
3. Cholera infantum is generally caused by germs in milk.
4. Babies should be carefully looked after, so that they will be able to resist the germs of intestinal diseases.
5. Diarrhœas and cholera infantum are infectious.

CHAPTER XX

DISEASE GERMS IN WATER

The disease germs that are most common in water are the germs of intestinal diseases. We shall therefore consider the question of a pure water supply. The importance of this subject is often not appreciated, for many people neither realize the great number of deaths that are due to impure water nor understand that it is possible to prevent most of these deaths.

The importance of a pure water supply. By filtering their water supplies through beds of sand, Albany, New York, and Lawrence, Massachusetts, have saved two thirds of the people who would have died of typhoid fever, if they had continued drinking impure water. Vienna changed from the polluted Danube River water to a pure water supply, and found that its death rate from typhoid was only one thirtieth what it had been. Certain towns in the Philippine Islands have been supplied with artesian water, and in those towns there are only about one half as many deaths as there were when impure water was used.

FIG. 60. For many years Pittsburg has had the highest death rate from typhoid fever of any of the large cities of America. Can you tell why?

Germ diseases that are contracted from water. The diseases that are most frequently contracted from water are cholera, typhoid, dysentery, and diarrhœa. The germs of these diseases come from the bodies of human beings, reach water that is used for drinking purposes, and get back to the human mouth. In our country, typhoid fever is the most important of the water-borne diseases, although in the southern half of the United States dysentery and diarrhœas are widespread and serious diseases.

Not only are the deaths from typhoid and other intestinal diseases reduced by using pure water, but for some reason a marked decrease in the number of deaths from pneumonia, tuberculosis, and several other diseases seems to follow changing from impure to pure water. The reason for this decrease is not yet fully understood. It is known, however, that in pneumonia, influenza, diphtheria, and tuberculosis the germs are practically always in the wastes from the alimentary canal, and tubercle bacilli have been found in the water of a stream that received the drainage of a tuberculosis sanatorium. It seems probable that the germs of respiratory diseases live in water and that many persons contract these diseases through impure drinking water.

How disease germs get into drinking water. Usually, disease germs either get into water from sewage or are washed into the water from soils that have been polluted with wastes from the human body. They may get into a well or cistern if a person who has germs on his hands works around the pump or handles the water buckets; a stream may be polluted by washing clothes from a diseased person in it, or by a diseased person

bathing in it; but in general, disease germs are washed out into waters from polluted soil. The following history of the typhoid epidemic that occurred in Plymouth, Pennsylvania, in 1885, shows how the water supply of a town may be infected with germs. During the winter of 1884–85, a man living on the bank of a stream that flowed into the town reservoir was stricken with typhoid fever. The wastes were thrown out on the snow and in the spring the waters from the melting snows and the rains washed these germs into the water supply of the town, and typhoid fever suddenly broke out. The city had a population of about 8000, and during the height of the epidemic from 50 to 200 persons a day were attacked. All together there were 1104 cases and 114 deaths. People who drank from wells escaped, and there is no doubt that the germs came from the public water supply.

Epidemics like the one in Plymouth are, of course, uncommon, but if you will investigate you will probably find that in the town or community in which you live several persons die each year from diseases that are mainly due to water.

Dangerous waters. Any water that comes from the surface of the ground is likely to contain disease germs. Shallow wells, springs, and small streams are the most dangerous of all waters. It is not safe to use water from these sources, no matter how clear and pure it may seem; for in the country, where people drink chiefly from wells, typhoid fever is more common than it is in our most crowded cities, and in the mountain regions, where the people drink from the most beautiful clear springs and streams, typhoid is a great scourge. Experience

shows that intestinal diseases follow the drinking of surface water, and it is not the part of wisdom to fail to profit by the experience of those who have lived before us.

Safe waters. In general, waters that do not come from the surface of the ground are safe. Deep artesian wells (except in rare instances in mountain regions) furnish water that is absolutely safe. Rain water that is caught and stored away in tanks above the ground is safe also. There is a common idea that dangerous germs may be blown up on a roof in dust, but the germs of intestinal diseases die if they are thoroughly dried, and are not found in rain water that has been kept from touching the ground. Underground cisterns that are thoroughly cemented are much safer than wells. Yet there is danger of ground water getting into a cistern around the top, or if part of the pipe that carries the water from the roof is underground, germs may easily get into the cistern through this pipe. There is also danger of germs falling into an underground cistern from the platform above. Distilled water is perfectly safe, but some bottled spring waters contain bacteria.

Keeping germs out of wells. In country regions wells will probably be the principal source of drinking water for many years, and it is important that they be made as safe as possible. In guarding a well from dangerous germs, the following are the chief precautions to be taken: —

Keeping surface water out of wells. Very few bacteria live deeper than three or four feet in the ground, and water, as it comes from the ground into a well that is as much as twenty feet deep, is usually free from germs. In

most cases the pollution of the water in such a well comes from the surface water getting into the well when it rains and carrying with it germs from the upper layers of the soil.

To keep a well free from dangerous bacteria, it should first of all be located on high ground and away

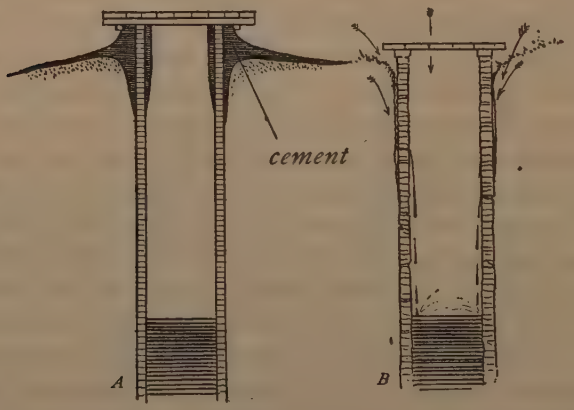


FIG. 61. *A* shows a well so arranged that surface water and germs are kept out of it. *B* shows how surface water and germs get into a well.

from all pigpens, stables, or other outbuildings. Under no circumstances should any puddles of water be allowed near it. Around the mouth of the well a tough clay should be spread and packed in thoroughly, to form a water-tight layer over the soil. This should slope so as to carry all water away from the well. The whole task is to keep surface water out, and this can be done still better by cementing the upper part of the wall and laying a circle of cement over the surface of the soil, as is shown in Figure 61. The platform

should be wide enough to keep any surface water whatever from running down in behind the wall and getting into the well.

The above precautions will do much to keep out of a well not only bacteria that are in the soil, but matter on

FIGS. 62 and 63. From which well would it be safe to drink the water?

which bacteria can feed and multiply. Yet if the earth about a well is polluted (as it is in thickly settled regions where there are many dry closets), some germs are certain to find their way into the water. For this reason it has often been necessary in towns and cities to fill up wells, and where there is reason to think that a well has been the cause of disease, the use of water from it should certainly be stopped.

Keeping germ carriers away from wells. No person who is sick, or who is caring for a case of infectious disease, should work with well buckets or about a pump. Neither is it safe to use water from a well where many people handle the rope and buckets, for we are finding

that germ carriers among healthy people are so common that there is always danger that one of them may have been about the well. Any person who walks over ground that has been polluted with human wastes (as many dooryards are) and then stands on a well platform, may leave disease germs where they will get into the water. For this reason, a well should always have a clean, sound platform, built of two layers of boards to make it as nearly water-tight as possible, and the pump should be so arranged that water will not run back into the well around it. A well that is covered by a small house and from which water is pumped by a windmill is much easier to make safe than one in the open, from which the water is taken by a hand pump or drawn out by buckets.

Freeing water from disease germs. It is the duty of every city either to secure pure water for its inhabitants, or, by filtering or in some other way, to remove dangerous germs from the water that it sends to the homes of its people. Many cities fail to do this, however, and when one is compelled to use impure city water, or water from an ordinary well or spring, the best plan is to boil it. Simply bringing it to the boiling point is enough to kill all dangerous germs (page 158). Most house filters are almost useless, and some of them are worse than useless, for they catch and hold matter in which bacteria breed and multiply, and the bacteria pass through the pores in most of them. Very fine porcelain filters, if they are carefully cleaned and attended to, do strain out bacteria, but they work very slowly, it is a great deal of work to care for them, and it is easier to boil water than to look after one of them. Filtering through animal

charcoal takes certain coloring matter out of the water and makes it look clear and bright, but it does not remove germs. It is always to be remembered that to use fruits, vegetable dishes, or milk vessels that have been washed in impure water may be as dangerous as to drink the water.

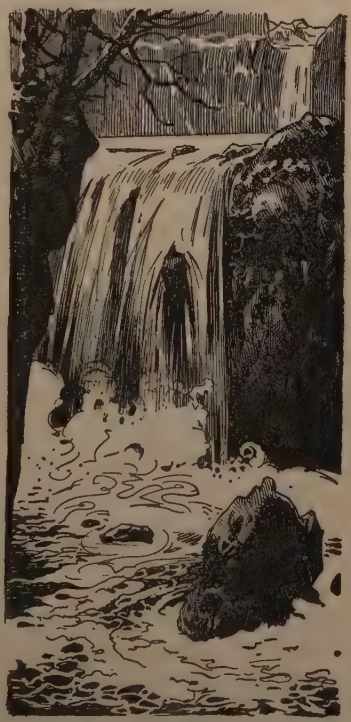


FIG. 64. Water like this is free from disease germs unless it has been polluted by wastes from the bodies of the sick.

The importance of boiling drinking water. Boards of health frequently send out warnings when it is necessary for the inhabitants of a city to boil their drinking water, and if these warnings were always followed, thousands of cases of sickness would be saved each year. All over the country, people are drinking from wells into which surface water is draining, and if these families would boil their water (or repair their wells) thousands of lives would be saved each year.

The fact that water is clear is no indication that it is free from germs, for germs are so small that they cannot be seen by the unaided eye. Because people have

been drinking water from a well for a hundred years is no indication that the water is pure, for it is possible for a well to have been in good condition twenty-five years ago and to be receiving surface water now. It is possible, too, that many of the people who have drunk water from the well during the hundred years have died of diseases that they contracted from the water. Do not make the mistake of thinking that a well can be made safe by cleaning it out occasionally. Typhoid germs live longer in clean water than in dirty water, and a well can be made safe only by keeping disease germs out of it.

POINTS TO BE REMEMBERED

1. Nothing is more important in preventing germ diseases than pure drinking water.
2. Intestinal diseases in particular are spread through water.
3. The disease germs in water come from the human body.
4. They get into the water from germ-laden wastes, from the hands of germ carriers, and in other ways.
5. Great epidemics of typhoid fever and cholera have been caused by polluted water.
6. Water from the surface of the ground (water from streams, springs, and shallow wells) is unsafe for drinking.
7. Artesian water is usually safe, as is rain water that has been kept free from pollution.
8. To keep wells free from germs, surface water and dirt from the platform must be kept out of them, and persons who are carrying germs should be kept away from them.
9. Impure water should be boiled before it is drunk.

CHAPTER XXI

OTHER BACTERIAL DISEASES

Besides the diseases we have already studied, there are many other diseases of man that are caused by bacteria. Most of these are tropical diseases, and we shall not even mention them here. In a considerable number of other diseases the particular germ that is responsible has not been surely determined, and we cannot tell whether these diseases are due to bacteria or to protozoa. There is also a great number of bacterial diseases of animals, and a considerable number of bacterial and fungous diseases of plants, for animals are seldom sick, and plants are almost never sick, unless they are attacked by germs. In this chapter we shall take up a few very different diseases that it is well to understand.

MENINGITIS

Every year there are in the United States about 15,000 deaths from meningitis. The disease is caused by germs growing in the membranes around the brain and spinal cord. About two thirds of all cases of this disease are caused by pus-forming bacteria, the pneumonia germ, the influenza germ, the tuberculosis germ, or the typhoid germ. The other cases of meningitis are caused by a special germ (*Meningococcus*)[1] that is not found in other diseases. When meningitis is caused by this germ, it is an infectious disease, often runs in epidemics, and is sometimes called epidemic cerebro-spinal

[1] Pronounced men-in′-go-kok′-kus.

meningitis. Its attack is sudden and severe, and until very recently most cases ended in death.

How the germ of epidemic meningitis enters the body. The germ of epidemic meningitis is abundant in the discharges from the nose of a patient who is suffering with the disease. It dies quickly from drying, and does not grow naturally in animals or outside the human body. It is spread in ways that do not require it to be long outside the body, as by handkerchiefs, drinking cups, the hands, or by droplets that have been coughed or sneezed out into the air. It is sometimes found in the noses of persons who have been about meningitis patients, and it is believed that it reaches the brain by working upward through the roof of the nasal chambers. Any one who is carrying this germ should be quarantined, and the sputum and discharges from the nose of a meningitis patient should be carefully destroyed.

FIG. 65. The germ of epidemic cerebro-spinal meningitis.

Curing meningitis. Recently a serum prepared from the blood of the horse has been used in the treatment of epidemic meningitis.[1] This serum contains both an antitoxin and a substance that kills the meningitis germs. It is proving of great value, for of the patients that have been treated with it only about 25 per cent have died, while of cases that are not treated with the serum, from 70 to 75 per cent end fatally. Like the antitoxins for diphtheria and tetanus, meningitis serum should be used as early in the case as possible.

[1] This serum is of no value in cases of the disease caused by germs other than the meningococcus.

SORE EYES

Different germs — the diphtheria, the pneumonia, or the pus-forming bacteria — may cause sore eyes, but there is a particular bacterium (*Koch-Weeks bacillus*) that causes the epidemic form of sore eyes often called "pink eye." This germ dies quickly from drying, and is not found to any extent in the air, but it is easily transferred on handkerchiefs, towels, wash basins, on the hands and by flies, and children with this disease should not attend school. The infected eye should be carefully covered to keep germs from getting into the other eye. The severe form of sore eyes called granular lids (*trachoma*) is very infectious, but there is some doubt about the germ that causes it. It is never safe to wash the eyes in a public wash basin or to wipe them on a public towel.

FIG. 66. The bacillus that causes "pink eye."

RHEUMATISM

Acute rheumatism is caused by bacteria that settle in the joints and cause inflammation there. The germ has been thought by some to be a variety of streptococcus. Others think that while it is very similar to streptococcus, yet it is a different germ. When it attacks the valves of the heart, it may cause death.

LEPROSY

Leprosy is caused by an exceedingly slow-growing bacillus that is similar in many ways to the bacillus of tuberculosis. The germ probably gets into the body by

being inhaled, or through wounds, or possibly by the bite of the mosquito.

BUBONIC PLAGUE

Bubonic plague is the disease that in the Middle Ages was called the Black Death. The germ attacks rats as well as men, and men usually get the disease from the bites of fleas that have been living on plague-stricken rats. At the present time there is a widespread epidemic of plague in the world, the disease being in all the continents and in fifty-two different countries. It is most severe in India, where in 1907 it caused nearly a million deaths.

CHOLERA

The cholera germ grows in the intestines and produces a toxin so powerful that death sometimes comes in a few hours. The germs are spread in the same ways that typhoid germs are spread. At the present time cholera is feared only in those countries where the germ theory of disease is not understood. In all countries where it is possible to get the people to guard their food and water, cholera has now disappeared.

MUMPS

It is believed that the cause of mumps is a small coccus that grows in the salivary glands. The incubation period is from thirteen to twenty-one days, and the patient is dangerous to others for a week after the swelling of the glands is gone.

BACTERIAL DISEASES OF PLANTS AND ANIMALS

Bacterial diseases of animals. Among bacterial diseases of animals are the following: Swine plague and

cholera among hogs; roup and cholera among fowls; foot-and-mouth disease, pleuro-pneumonia, milk-sickness, and black-leg among cattle; distemper and glanders among horses, and many other diseases of animals that cannot be mentioned here. The glanders bacillus may attack man (sometimes causing a fatal illness), and milk-sickness and foot-and-mouth disease may be contracted by man from milk.

Bacterial diseases of plants. Pear blight; the wilt disease of young cucumbers, melons, squashes, and pumpkins; the brown rot of the potato, tomato, and eggplant; the black rot of cabbages, rutabagas, and turnips; a disease of sweet corn; a knot disease of the olive; and a rot of the calla lily — all these are plant diseases that are caused by bacteria. It is thought that bees carry pear-blight germs from tree to tree during blossoming time, and that they are entirely responsible for the spread of the disease. The germs of wilt diseases are probably spread by beetles and squash bugs that feed on the diseased plants.

FIG. 67. A muskmelon plant that has been attacked by wilt bacteria.

Disease caused by fungi. Many diseases of plants — rusts, smuts, mildews, many of the rots, and various other diseases — are caused by small plants (fungi) that are similar to molds. These fungi are much larger than bacteria, their bodies being composed of long, thread-like filaments. A few fungi enter the hair follicles and grow in the human skin. Among the diseases caused by them

are ringworm, barber's itch, and a kind of itch that attacks any part of the body. Thrush, a white growth found in the mouths of young babies, also is caused by a fungus.

POINTS TO BE REMEMBERED

1. Meningitis may be caused by any one of several germs, but the epidemic form of the disease has a special germ of its own.
2. In epidemic cerebro-spinal meningitis, the germ is in the discharges from the nose of the patient and enters the body through the nose.
3. A new serum is proving very valuable in treating this disease.
4. Great care should be taken to guard the eyes when sore eyes are epidemic, and all cases of infectious sore eyes should be quarantined.
5. Acute rheumatism, leprosy, plague, and cholera are bacterial diseases.
6. Bacteria cause many diseases of animals and plants.
7. Many plant diseases and some skin diseases in man are caused by fungi that are larger than bacteria.

CHAPTER XXII

PROTOZOA

THE bacteria are the smallest of all plants. The protozoa are the smallest of all animals. The smallest protozoa look like tiny specks under the most powerful microscope, and are no larger than very small bacteria. The largest of them are much larger than any bacteria, but they can barely be seen with the naked eye.

Protozoa are abundant in both fresh and salt water. Many of those that live in the ocean have shells, and so

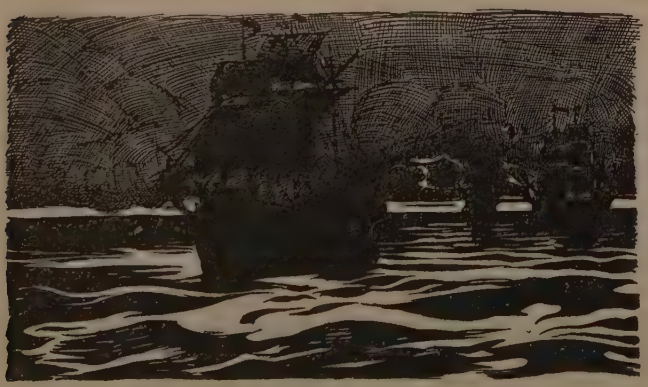


FIG. 68. Phosphorescence in the water is caused by multitudes of protozoa.

abundant are they that great beds of chalk and limestone are built by them. Others are phosphorescent (give off light), and in the warmer seas the waves at night are often fringed with light from the multitudes of protozoa in the water.

Many kinds of protozoa live in the bodies of animals, and almost every animal, from worms and insects up to man, suffers from diseases that are caused by them. Among the protozoan diseases of man are several that

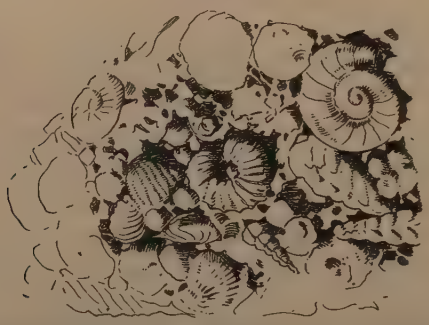


FIG. 69. Shells of protozoa in a piece of chalk as seen under a microscope.

are carried by insects, and these diseases are worse in the warmer parts of the earth where insects are most abundant.

POINTS TO BE REMEMBERED

1. Protozoa are very small animals.
2. Protozoa are abundant in both fresh and salt water.
3. They cause many diseases of animals and men.
4. Several protozoan diseases are spread by insects.

CHAPTER XXIII

MALARIAL FEVER AND YELLOW FEVER

MALARIAL fever does not cause so many deaths as some other diseases, but because it is found over a great part of the world, and because in malarial countries a great number of people are affected by it for long periods of time, malaria must be counted as one of the most important of the diseases that afflict mankind.[1] No community can prosper as it should while its people have malaria, for a person who is suffering from this disease cannot have the energy and ambition that he should have to carry on his work.

The germ of malaria. Malaria is caused by small protozoa that live in the red blood corpuscles. A malaria germ grows and becomes larger in a corpuscle and then divides into a number of parts, each of which is a young germ. The corpuscles then break into pieces, leaving the young germs free in the blood. Each young germ now enters a fresh red corpuscle, grows in it, and divides into a

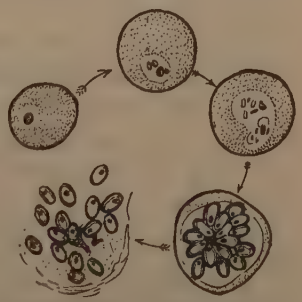


FIG. 70. The growth of the malaria germ in a red blood corpuscle.

[1] In malarial countries from 25 to 60 per cent of the people may have the germ of malaria in the blood. Many of those who are carrying the germ do not have chills and fever and do not know that they have malaria, but they are suffering from a slow, chronic form of the disease that robs them of their strength.

number of germs. These young germs then break forth and attack other corpuscles.

The cause of the chill in malaria. While they are growing in the corpuscles, the malaria germs produce toxin. When the corpuscles break down at the time the germs come out into the blood, a large amount of toxin is set free in the blood at one time. This toxin poisons the cells of the body and brings on the chill and fever. There are several different kinds of malaria germs, and the chill comes every day, every other day, or every third day, according to the length of time it takes for the germs to become full-grown and break out of the corpuscle. In their growth the malaria germs destroy great numbers of red blood corpuscles, and the loss of these millions of corpuscles, as well as the poisoning of the cells by the toxin, injures the body.

How the malaria germ gets into the body. The malaria germ grows in a certain kind of mosquito (page 112) as well as in man, and it gets into our bodies from the bites of these mosquitoes. When the mosquito feeds on man, it thrusts its proboscis (bill) down through the skin and sucks out the blood. When a mosquito draws blood from a person who has malaria, it takes malaria germs into its stomach with the blood. These germs pass into the walls of the mosquito's stomach and multiply in little sacs on the outside of the stomach walls. The sacs then burst, and great numbers of the germs pass through the mosquito's body to the salivary glands. The germs appear in the

FIG. 71. The stomach of a mosquito that is infected with malaria. The malaria germs grow in the sacs on the mosquito's stomach.

saliva in about ten days from the time when they were first taken into the stomach.

Now the opening in the proboscis of the mosquito is too small to allow the blood corpuscles to pass up

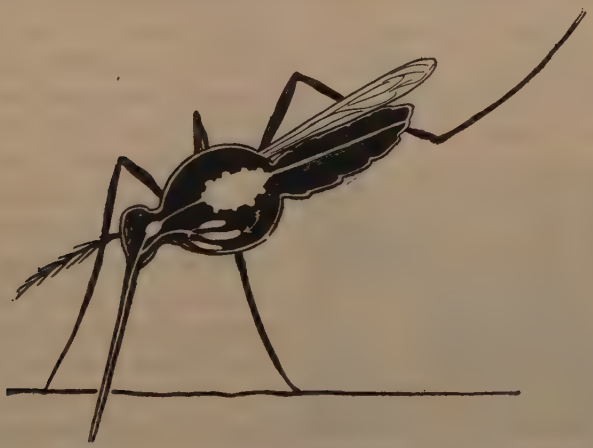


FIG. 72. Diagram of a mosquito's body. The malaria germs pass from the stomach to the salivary glands. Then they are injected through the proboscis into the persons whom the mosquito bites.

through it, and when the mosquito bites it injects saliva into the wound.[1] The saliva breaks up and dissolves the corpuscles, and the mosquito is then able to draw out the blood. If the malaria germs are in the salivary glands of the mosquito, they will, of course, be injected into the wound with the saliva. Unless the body is able to destroy them, the germs then enter the red corpuscles, and in about a week from the time the man was bitten the disease appears.

[1] It is the poisonous saliva of the mosquito that causes the itching and swelling that follow a mosquito bite.

Malaria spread only by mosquitoes. It is a common idea that malaria is caused by drinking impure water or by "miasmas," or poisonous vapors, from swamps or damp ground. This idea is not correct. In Italy many experiments have been made, during which persons drank water from the worst malarial marshes in Italy and Sicily, and inhaled the air of the marshes. Not a single case of malaria ever followed these experiments. Near Rome, in a hut that stood in the very midst of the Pontine marshes (one of the worst malaria-stricken regions in the world) two English scientists lived for several months during the worst of the malaria season. They breathed the air that came from the damp lowland on which the house stood, and drank the water of the region that was supposed to cause malaria. In every way they lived as the people about them lived, except that in the evenings they retired to their carefully screened hut before the mosquitoes came out, and stayed behind their screens until the sun was up and the mosquitoes had retired. These men had no symptoms whatever of malaria, although the people all about them were suffering from the disease.

FIG. 73. By screening themselves from mosquitoes, two Englishmen lived for several months in one of the worst malarial regions in all Italy, without symptoms of the disease.

At the same time mosquitoes were caught in Italy, and after they had been allowed to bite a malaria patient, were sent to London. There a physician who

lived in England and who had never had malaria allowed them to bite him. In a short time he developed a case of Italian malaria and the germs were found to be abundant in his blood. These and a large number of other similar experiments leave no room to doubt that it is by the bite of the mosquito and not by water or by damp air that the malaria germ enters the body.

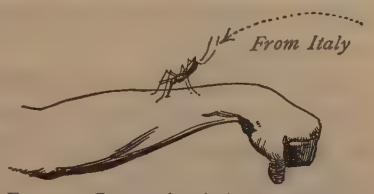


FIG. 74. Germs of malaria were sent from Italy to England *in a mosquito*, and a physician who was bitten by the mosquito developed malaria.

Killing malaria germs. There is no medicine known that will kill the germs of most diseases after they get into the body, without at the same time killing our own cells. Fortunately for us, the human body can endure an amount of quinine that will kill the germs of malaria. There is therefore a cure for malaria.

Preventing malaria. It is better to prevent any disease than to try to cure it, and it is better to prevent malaria than to try to kill the germs after they get into the body. The following are the best ways of preventing the spread of malaria :—

Screening malaria patients from mosquitoes. Mosquitoes that have not bitten persons who have malaria are free from the germs, and cannot spread the disease. But it has been found that in a house where there is a malaria patient the mosquitoes are usually infected, and that they are able to give the disease to others. In regions where there is only an occasional case of malaria, or where only a few persons are living close together (as in a country farmhouse), much can be done

to check the spread of malaria by keeping patients under mosquito nets until the germs disappear from the blood.

Avoiding unnecessary exposure to mosquitoes. Persons living in malarial regions should keep their houses carefully screened, and should sleep under mosquito nets during the mosquito season. They should not go out early in the morning or late in the evening where mosquitoes can bite them, and on cloudy days they should keep away from woods and swamps where mosquitoes are flying. Care should always be taken in selecting places for camping and fishing trips, for one night spent among mosquitoes may start an attack of malaria that will last for months.

Destroying mosquitoes. In towns and around country houses that are at all favorably located, mosquitoes may be destroyed by removing their breeding places. So well do we understand how to do this that there is now little reason why one who does not live in a swampy region should have malaria. The best ways of destroying mosquitoes will be discussed in the next chapter.

YELLOW FEVER

Within the memory of those still alive, yellow fever has left its dead unburied in our country, and even yet it is occasionally brought from the West Indies or Central America to some of our southern cities. The germ has not been discovered, but it is carried by a mosquito of a certain kind (Fig. 81), and the disease is contracted only from the bites of infected mosquitoes of this kind. After a mosquito has bitten a yellow

fever patient, at least twelve days must pass before it can give the disease to any one else. Once infected, a mosquito remains infected through life, and the young of a mosquito that is carrying the germs can also transmit the disease. All mosquitoes that have had an opportunity of biting a yellow fever patient should be killed (page 115).

FIG. 75. Dr. Walter Reed. On the tablet marking his grave is the inscription: "He gave to man control over that dreadful scourge, yellow fever."

By screening yellow fever patients, by quarantining, and by persistently fighting mosquitoes, yellow fever can be controlled, and it is not probable that it will ever again be allowed to spread to any extent in our country.

POINTS TO BE REMEMBERED

1. Because of the great number of persons who are attacked by it, malaria is a very important disease.
2. The malaria germs grow in the red blood corpuscles.
3. They break forth from the corpuscles at the time of the chill.
4. The malaria germ is carried only by one kind of mosquito.
5. The malaria germ is one of the very few germs that may be killed with medicine after it gets into the body.
6. Malaria may be prevented by screening malaria patients, by avoiding exposure to mosquitoes, and by destroying mosquitoes.
7. Yellow fever is contracted only from the bite of a mosquito.

CHAPTER XXIV

MOSQUITOES

The mosquito, more than any other one agency, has driven man from the warmer and more fertile portions of the earth to the colder and more barren regions. It carries not only the germs of malaria, but also of yellow fever and probably of dengue, or "break-bone" fever, a disease common in the tropics and found to a certain extent in some of our southern states. The germs of several diseases of man not found in our country, and of certain diseases of birds, are also carried by mosquitoes. Where it is possible to do so, the best way to end all these diseases is to destroy the mosquitoes. To work at this intelligently it is necessary first to know the life history of the mosquito.

FIG. 76. *A* is a raft of mosquito eggs; *B* is a single egg.

Life history of the mosquito. The mosquito lays its eggs on water. In about a day the egg hatches into a *larva* (commonly called a *wriggler* or *wriggle-tail*) that swims about actively in the water. The larva takes in air through a breathing tube, which it thrusts out through the surface of the water to the air, as shown in Figure 77. In from seven to fourteen days the larva changes its form. The head and the fore part of the body become much heavier, and the breathing tubes shift to the back of the body. In this stage it is called a *pupa* (commonly called a *tumbler*, because instead of wriggling as it swims,

it tumbles over and over). In from two to five days — ten to twenty days from the time the egg was laid — the pupa splits down the back, and the adult mosquito comes out and flies away.

In the larva and pupa stages, mosquitoes feed on small plants and animals that are in the water. In the adult form, they live chiefly by sucking the juices from plants, but they eagerly attack animals and suck the blood from them when there is an opportunity to do so. How long a mosquito naturally lives in the adult form is

FIG. 77. *A* is a mosquito larva; *B* is a pupa; *C* is an adult mosquito coming out of an old pupa.

not known, but one has been kept for seventy-six days, and considerable numbers of them live through the winter, hidden away in crevices and cracks. The young of the mosquito are not killed by being frozen in ice, and mosquitoes often hatch out in the spring from larvæ that have lived through the winter.

Anopheles. The kind of mosquito that carries the germ of malaria is called *Anopheles* (A-nŏf'-ĕ-lēs). It is

a small, almost silent mosquito, that does most of its biting in the early part of the night. It can readily be distinguished from other mosquitoes by the black spots on its wings, and by its habit of elevating the back part of the body, or standing up on its head, when resting and biting. Other mosquitoes are often carried considerable

FIG. 78. *A* is the Anopheles mosquito (the mosquito that carries malaria), showing its position while resting, and the spots on its wings. *B* shows the common mosquito (Culex).

distances by the wind,[1] but the Anopheles has a habit of clinging to weeds, shrubs, and bushes when the wind blows, and is not often found far (seldom more than two hundred yards) from the place where it is hatched. The mosquitoes that give people malaria are usually raised by those same people, or by their neighbors.

Destroying the breeding places of mosquitoes. The first thing in the fight with mosquitoes is to deprive them of breeding places near human dwellings. An old fruit

[1] There are some mosquitoes that breed in salt marshes and travel for miles. These rarely enter houses, and they do not carry malaria.

can may catch and hold enough rain water to breed a large number of mosquitoes; in the course of a summer, an almost unlimited number[1] can come from a water barrel or an open cistern; and an undrained ditch by the roadside may supply enough mosquitoes to torment and infect with malaria all the people in the vicinity.

FIG. 79. The gutter over this doorway became stopped up with leaves, and in the water that stood there, hundreds of mosquitoes were hatching. (*After photograph by the Richmond Board of Health.*)

Old cans and pans should be cleared away; water barrels, tanks, and cisterns should be screened so that the mosquitoes cannot get to them to lay their eggs; sagging eave troughs should be braced up so that no water will stand in them, for in an eave trough the larvæ may start in a very small quantity of water and then be washed down into the cistern, where they will complete their development. All pools and puddles about houses should be drained; and wells must be watched and if necessary covered, for sometimes the larvæ are found in wells. Weeds and shrubbery in which the mosquitoes can find a dark, cool place to hide during the hot part of the day, or when the wind blows, should be cut down. As long as mosquitoes are found about the house, the work should be continued, for if all breeding places near houses are removed, Anopheles mosquitoes and

[1] Nineteen thousand eggs and young mosquitoes have been found in a rain barrel at one time.

generally all other mosquitoes will disappear. The work of destroying mosquitoes in cities and towns must be taken up by public officials who have authority to compel every one to remove the breeding places on his premises.

Killing mosquito larvæ with kerosene. When pools of water cannot be drained, it is an easy matter to kill all young mosquitoes in them by pouring a little kerosene

FIG. 80. This house was so infested with mosquitoes that the owner was about to sell it at a sacrifice, when he learned from a health official that a half-hour spent in draining the ditch or in sprinkling it with kerosene would free his family from annoyance and the danger of disease. Sprinkling a ditch with kerosene will kill the mosquito wrigglers, but it is better to drain the ditch.

on the water. This forms a film over the water, shutting the larvæ off from the air, and killing them in a few minutes. If the kerosene is washed away by rains, it must be renewed within ten days, for this is about the time it takes a mosquito egg to grow into a mosquito. Minnows, goldfish, and other small fish feed on the mosquito larvæ, so by introducing these into a pond, the number of mosquitoes that breed there may be greatly lessened.

Killing adult mosquitoes. After mosquitoes have been allowed to hatch and scatter themselves, it is hard to get rid of them, but when mosquitoes in a house are known to be infected with yellow fever or malaria, it is very important to kill them at once. This is usually done by burning sulfur in the rooms that contain the mosquitoes.[1] In fighting diseases that are spread by mosquitoes, the importance of screening sick persons who may infect the mosquitoes with germs must not be forgotten. Where mosquitoes are plentiful, often the only way by which an individual can protect himself is to screen his house and bed and to stay indoors when the mosquitoes are abroad.

FIG. 81. The yellow fever mosquito (Stegomyia). This mosquito has light bands around the body and on the legs. It breeds near houses and does not fly far from where it is hatched.

Communities that have successfully fought mosquitoes. It is a very easy matter, and not at all expensive, to banish mosquitoes almost completely from a town near which there are no extensive natural breeding places. Even in regions where there are large marshes and many streams and ponds, by systematic work communities can free themselves from mosquitoes. This has

[1] The fumes of burning sulfur kill flies, fleas, and bedbugs, as well as mosquitoes, but they destroy the color in carpets and other cloth articles, and blacken the gilt on picture frames, book covers, and furniture. Burning insect powder (*pyrethrum*) will stupefy flies and mosquitoes so that they can be swept up and burned.

been done in Havana and New Orleans during yellow fever epidemics, and the inhabitants of the North Shore of Long Island and of certain towns in New Jersey, where the mosquitoes were formerly so abundant that they were a veritable pest, have now conquered their winged enemies. In this book there is not space to tell of the work that has been done in these places, but from the Department of Agriculture at Washington, D.C., and from state and city boards of health, bulletins can be obtained that give many interesting facts about mosquitoes, with directions for fighting them.

POINTS TO BE REMEMBERED

1. Mosquitoes carry malaria and yellow fever.
2. In ten days the mosquito can pass through the larva and pupa stages and come out in the adult form.
3. The mosquito that carries malaria has spotted wings, and when resting stands up on its head.
4. The mosquitoes that carry malaria and yellow fever spend their lives near where they hatch.
5. A town or a country house can be freed of mosquitoes by removing the breeding places.
6. Public health officials are absolutely necessary in fighting mosquitoes.
7. Mosquito larvæ may easily be killed with kerosene.
8. When the mosquitoes in a house are infected with disease germs, they may be killed by burning sulfur in the house.
9. Many towns and communities, some of them very unfavorably located, have freed themselves from mosquitoes.

CHAPTER XXV

SMALLPOX

Up to about a hundred years ago, smallpox was one of the most terrible diseases known to man. It is estimated that in the eighteenth century it killed 60,000,000 people, and that 6,000,000 of the 12,000,000 inhabitants of Mexico died from it when it was introduced into that country by the Spaniards. In Europe nearly every one sooner or later had to undergo an attack of the disease. "It was always present, filling the churchyards with corpses, tormenting with constant fears all it had not yet stricken, leaving on those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, and making the eyes and cheeks of the betrothed maiden objects of horror to the lover." Fortunately for us, a method of preventing smallpox has been discovered, and in civilized countries it has now become a rare disease.

The germ of smallpox. It is believed that smallpox is caused by a small protozoön that lives in the skin and in the lining of the mouth, throat, and nose, and sometimes in the trachea and esophagus. The germs cause pustules or sores to form in the deeper layers of the skin. These break through to the surface of the skin, and in the later stages of the disease the matter from these pustules dries as scabs over the body. The incubation period of smallpox is from seven to twenty-one days.

Some races of smallpox germs are weak and produce a mild type of the disease. Other races are very virulent

and cause smallpox of a most malignant type. In this disease, as in diphtheria and other infectious diseases, weak races of germs are likely to become strong, and a mild type of the disease is likely at any time to change to the malignant form. There is no excuse for the physician who, to save a family or a town from inconvenience, knowingly pronounces a mild case of smallpox to be chicken pox; for from a mild case of the disease, germs may be spread abroad that will bring many persons to their graves.

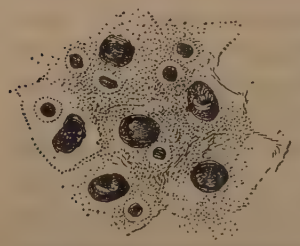


FIG. 82. Germs of smallpox in the cells of the skin. The small, dark bodies with the clear spaces about them are the germs.

How smallpox germs are spread. The germs of smallpox are abundant in the matter on the skin of a smallpox patient, they are in the discharges from the mouth and nose, and are found in great numbers in the scales that come from the skin during recovery from the disease. These germs may be scattered about by the patient's coughing or sneezing, they are left on anything he touches, and they may very easily be blown through the air in the light, dry scales that come from the skin. Smallpox germs may be dried for months without being killed, and on clothing, books, letters, old rags, and many other things, they are easily carried about. It is therefore very important that a smallpox patient should be quarantined, and that everything about him should be thoroughly disinfected (page 159).

VACCINATION

To very few human beings has nature given white corpuscles and germicidal substances that can resist the smallpox germ. Up to the time vaccination began to be practised, more than 95 per cent of all persons suffered

FIG. 83. A vaccinated arm.

FIG. 84. A smallpox victim.

from it, and people considered it a disease that every one must have, just as we look on chicken pox and mumps as diseases that most of us will probably have to go through with sooner or later. About the year 1800 vaccination began to be practised, and smallpox at once began to decline. Now vaccination is more or less compulsory in every civilized country in the world. Where it is thoroughly carried out, smallpox has almost ceased to exist, but where the people are not vaccinated, or a considerable number of them are not vaccinated, it is still impossible to prevent the spread of the disease. This is because the smallpox germ can be dried and blown about for weeks and months without killing it,

and because it is so powerful a germ that if 100 unvaccinated persons are exposed to it, from 95 to 98 of them will be attacked by the disease.

Vaccination an almost perfect protection against smallpox. In 1870–1871, during the Franco-Prussian War, all German soldiers were vaccinated, while only a part of the French soldiers were vaccinated. In the French army there were 6000 deaths from smallpox, and the French wounded suffered heavily from the disease. In the German army there were only 278 deaths from smallpox, and among the German wounded who lay in the same tents with the French wounded, not a single case occurred. At the same time the German soldiers suffered as much as the French, or even more, from typhoid fever, dysentery, and other germ diseases.[1]

FIG. 85. Edward Jenner, who in 1797 discovered vaccination, the greatest medical discovery the world has ever known.

From time to time certain persons in England have opposed vaccination, and for a while the center of this opposition was in Gloucester. In 1895 that city had a population of 42,000, among whom were a very consid-

[1] There were 73,396 cases of typhoid fever and 8709 deaths from typhoid in the German army during the Franco-Prussian War. This shows that it was not superior sanitation or medical attention, but vaccination, that protected the German soldiers from smallpox.

erable number of persons who had not been vaccinated. In the last weeks of 1895 smallpox broke out, and a great epidemic of 1979 cases and 439 deaths occurred. An attempt was made to control the disease by quarantining and careful disinfection, but this was an entire failure. In January, 1896, there were 28 cases, in February 146 cases, in March 644 cases, and in April 744 cases. By the end of April more than 36,000 of the inhabitants had been vaccinated, and Gloucester was the best vaccinated city in the world. The epidemic at once began to decline, and by August it had disappeared.

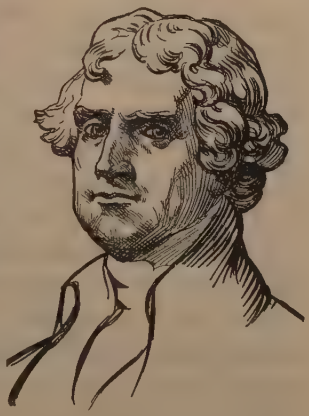


FIG. 86. Thomas Jefferson, one of the most broad-minded and far-seeing Americans of his time. In 1806, writing to Edward Jenner, he said, "Future nations will know by history only that the loathsome smallpox has existed and by you has been extirpated."

In Philadelphia there was a considerable epidemic of smallpox during the years 1901–1904. During this period more than 3500 cases were admitted to the Municipal Hospital, and of these 3500 cases not one had been successfully vaccinated within five years. During this time many physicians and nurses were employed in the hospital, and more than 700 medical students were taken to visit the patients. Not one of all these persons contracted smallpox except one student who was opposed to vaccination and untruthfully said that he had been vaccinated. At one time it was necessary to enlarge the

hospital, and fifty or sixty workmen were employed to do this. All of them were vaccinated except two, and these two and no others took the disease. Again it was necessary to enlarge the hospital, and another squad of workmen was employed. For some reason two of these were not vaccinated. These two were attacked by smallpox, while again all the workmen who had been vaccinated escaped. Thus within the hospital all of the hundreds of persons who had been vaccinated escaped the disease, and all five of those who had not been vaccinated contracted it.

Many pages could be filled with similar statistics showing that vaccination almost surely prevents smallpox. Yet many persons seem never to have heard of these facts, for there are still in our country societies that actively oppose vaccination. Some people think that among those who do not believe in vaccination are some of the prominent physicians of the country. This is a great error, for hardly any of the physicians who oppose vaccination are even graduates of medical colleges, and none of them have any prominence in their profession. The leaders of medicine for the last hundred years have believed in vaccination and have practised it, and to-day there is not a prominent medical man in America who is opposed to it. On this point the Medical Society of the State of Pennsylvania says: "We know of *no physician of eminence in this country* who is not a believer in — nay, even an ardent advocate of — vaccination."

How vaccination protects against smallpox. The germ of smallpox flourishes in man. It grows in cattle also, causing the disease called *cowpox*. After growing in the cow, this germ seems to be weakened and changed so

that it grows feebly in man and has only a slight power of producing disease.

In vaccination, germs from a cow are put into the human body. Here they grow and begin to produce the mild inflammation that follows vaccination. The body now works up the germicidal substance for these germs, and because the germs are weak, the body is able to kill them out before they can multiply to any extent. After this is done, the germicidal substance remains in the blood, and if smallpox germs at any time get into the body, the germicidal substance is there ready to kill them and keep the disease from getting a start. A person who has been successfully vaccinated is therefore in much the same condition as a person who has had a light attack of smallpox, for he has in his blood a substance that will kill any smallpox germs that may get into his body.

How long vaccination protects against smallpox. After vaccination, the germicidal substance in the blood becomes weaker and weaker, but seldom disappears entirely. Just when it becomes so weak that it is necessary to be vaccinated again, it is impossible to say. Sometimes it is fairly strong after seven, eight, nine, or ten years. In a very few persons it disappears so rapidly that in nine months it fails to protect against smallpox. The safest way is to be vaccinated every few years, and when there is danger of being exposed to smallpox, to be vaccinated again if more than nine months have passed since the last vaccination. There can be no mistake in this, for if the germicidal substance is still strong in the blood, all the germs put in by vaccination will be killed and the vaccination will not take. If the

vaccination does take, it is a sure sign that the germicidal power of the body had run low and that another vaccination was needed.

Why every one should be vaccinated. *Every one should be vaccinated to protect himself.* We never know when the smallpox germ may come to us from the seats of a car, from a letter, from the clothes of some person, or in any one of many other ways. If smallpox germs do get to a person who has been successfully vaccinated, that person will in all probability kill out the germs and suffer no harm. If he has not been vaccinated, he will probably suffer from an attack of smallpox, and will run a considerable risk of losing his life. Even if he recovers, he will be fortunate if he is not more or less scarred and pitted for life.

Every one should be vaccinated to protect others. Persons who have smallpox cause expensive quarantine, they interfere with business and with schools, and by scattering abroad smallpox germs they endanger the lives of others. A person who refuses or neglects to be vaccinated and then takes smallpox, makes a public nuisance of himself, and it is neither fair nor right to be a nuisance to one's friends and neighbors. In 1885 *one* man carried smallpox to Montreal and started an epidemic that cost over three thousand lives.

No danger in vaccination. Vaccination causes only a mild inflammation and a small sore, and there is no danger from it when it is properly done. How little danger there really is from it is shown by the fact that 3,709,187 persons were vaccinated by government officials in the Philippine Islands, during the years 1907–08, without a single death. The greatly swollen arms and running

sores that sometimes follow vaccination are caused by pus-forming bacteria and are not a true part of vaccination at all. The pus-forming germs usually get into the wound in impure virus, from infected instruments (as from a lancet that has been used in opening a boil), from an

FIG. 87. In the Philippine Islands, before the American occupation, only a small part of the inhabitants were vaccinated. In 1897, about 40,000 people died from smallpox. In 1907, there were 304 deaths from this disease in all the islands. It is vaccination that has caused this decrease, for in most parts of the Philippines there is no quarantine or disinfection of a kind that would have any effect in controlling smallpox.

unclean skin, or from dirt that gets into the wound. Only pure virus should be used,[1] the skin and instruments should be clean, and the wound (like any other wound) should be protected from pus-forming and tetanus germs. When one gets a great sore on the arm, it is not possi-

[1] All bacteria that may be in vaccination virus can be killed by placing the virus for a time in glycerin, and the virus sent out by the best firms is now treated in this way. Only virus that has been "glycerinized" and sealed in glass tubes should be used.

ble to tell whether the vaccination virus is working or not, and many persons who think they have been successfully vaccinated have only had a growth of pus-forming bacteria in their arms.

A point about germ diseases that should be understood. It is a common idea that if the blood is "pure" we shall be protected from germ diseases, and if the blood is "impure" we shall suffer from these diseases. This idea is not correct. A person's blood may be as pure as any flowing in the veins of man, and yet that person will fall a victim to smallpox germs if he lacks in his blood the substance that kills those germs. His muscles may be like bands of steel and his blood may course along in all the purity and vigor of perfect health, and yet if in his blood there is not the particular substance that kills the tubercle bacillus, he had best beware of that germ. He may even, as we have already pointed out (page 13), have substances in his blood that will enable him to kill some kinds of germs and yet may fall an easy victim to germs of another kind. Resistance to germs is, therefore, not a question of pure blood, but a question of having in the blood particular substances that will kill particular germs.

In former chapters we have advised you to keep up the health of the body so that it will be able to kill germs, and it is true as a general statement that when the body is in health it is able to manufacture more of the substances that kill germs than it can manufacture when it is weak. You should know, however, that for reasons that are not understood, the body sometimes suddenly loses its power to resist germs even when it seems to be in health. You should also understand that before small-

pox germs nearly every one goes down as the wheat goes down before the sickle, and that the only way you can make yourself safe from this disease is to get your body, beforehand, to work up a supply of the germicidal substance for the smallpox germ. Therefore, when any one begins to tell you that health consists in keeping the blood pure, and that vaccination is contrary to the principles of health because it introduces into the body matter from a cow that will cause the blood to be impure — when any one talks to you after this fashion, pay no attention at all to him. For though your blood were as pure as the crystal water from a snow-capped mountain peak, it would not kill the smallpox germ unless it contained the germicidal substance for that germ. It is strong blood, and not pure blood, that we need in our battle with the germs.

POINTS TO BE REMEMBERED

1. Until vaccination was discovered, smallpox was the most dreaded of all diseases.
2. The smallpox germ can withstand drying and is easily spread.
3. Vaccination almost surely protects against smallpox.
4. In vaccination a weak race of smallpox germs from cattle is put into the body.
5. The body works up a germicidal substance to kill out these germs.
6. This germicidal substance then remains in the blood.
7. Any danger there may be in vaccination comes from bacteria that get into the wound and not from the vaccination itself.
8. It is best to be revaccinated every few years, and whenever one has been exposed to smallpox.
9. Every one should be vaccinated to protect himself and to protect others.

CHAPTER XXVI

OTHER PROTOZOAN DISEASES

In the tropics there are many protozoan diseases that are unknown in our country. Among these diseases is the slow and surely fatal *sleeping sickness* in Africa. This dreadful disease is now causing about 50,000 deaths each year and is spreading from the Congo region eastward over the continent. It is communicated to man by the bite of a fly, and in some villages from 30 to 50 per cent of the people are affected.

Another protozoan disease of hot countries (a severe malaria-like fever called *kala-azar*) is carried by the bedbug. Chronic dysentery is another very important protozoan disease, and there are also a number of other diseases that are almost without doubt caused by protozoa, although the germs that cause them are not certainly known. Among these diseases are Rocky Mountain or "spotted" fever (which is contracted from the bite of a tick), yellow fever, rabies, scarlet fever, measles, and chicken pox. In this chapter we shall study certain of these diseases that are of importance in the United States.

RABIES (HYDROPHOBIA)

Rabies is believed to be caused by a protozoön that grows in nerve tissue, especially in the brain and spinal cord. The germ gets into the body usually from the bites of dogs or cats. In man the incubation period is never shorter than fourteen days; usually it is five or six weeks, and it may be a year.

Preventing rabies. Practically all the rabies in our country comes from the bites of dogs, and by keeping dogs properly muzzled it is possible to stamp out the disease entirely, as has been done in several European countries.[1] It is a mistake to think that rabies develops in dogs because of hot weather or lack of water. The dog gets the germ into its body from the bite of another dog, and dogs may suffer from the disease at any time of the year. A rabid animal has a habit of scratching at its mouth to remove the tough saliva, and a wound from the claws of such an animal is dangerous.

FIG. 88. If all the dogs in our country could be muzzled for a few years, rabies would disappear. The dogs could then be unmuzzled without danger of the disease to man or beast.

[1] The following statistics give the number of deaths from rabies in England and Wales for each year, from 1887 to 1907, and show clearly how muzzling dogs checks the spread of the disease: —

Year	*Deaths*
1887	29
1888	14
1889	30
Muzzling enforced	
1890	8
1891	7
1892	6
Opposition to muzzling; ordinance not enforced	
1893	4
1894	13
1895	20
Muzzling again enforced	
Year	*Deaths*
1896	8
1897	6
1898	2
1899	0
1900	0
1901	0
1902	2
1903	0
1904	0
1905	0
1906	0
1907	0

The Pasteur treatment. There is no cure for rabies after the disease develops, but a preventive treatment has been discovered by a great Frenchman named Louis Pasteur. This treatment is founded on the same principles as vaccination. Weak germs are put into the body, and by killing these weak germs the germicidal power of the body is increased. The body then goes on and not only kills the weak germs that have been put into it during the treatment, but kills also the germs that are in the wound made by the rabid animal. Thus the disease is prevented. The Pasteur treatment is successful in nearly all cases in which it can be commenced in time. Where the materials for this treatment can be delivered within thirty-six hours after they are shipped, they can be sent by mail and the treatment can be given to the patient by his home physician.[1]

Treatment of wounds made by rabid animals. A very great safeguard against rabies is to treat promptly all wounds made by the teeth of animals with something that will kill the germs in the wound. Any disinfectant (page 159) is useful, but burning with nitric acid is the most effective remedy. This should be done by a

[1] There was formerly a curious superstition that certain stones, called "madstones," would prevent rabies. Some person in the community would possess one of these stones, and when any one was bitten by a rabid dog, the stone would be applied to the wound to "draw out the poison." It need hardly be said that madstones are of no use in preventing rabies, and that intelligent persons long ago gave up their use. It is perhaps well to know that in several instances rabies is believed to have been caused by the use of a madstone. The stone became infected with the germs from the blood and saliva in wounds to which it had been applied, and then, when placed on a wound made by a dog that did not have rabies, the germs were introduced into the wound and the disease was produced.

physician, to make sure that it is thoroughly done, and to guard against too great injury to the flesh by the acid. The best way is to wash the wound at once with turpentine, carbolic acid, bichlorid of mercury, or some other disinfectant, and then go to a physician. Treatment even after twenty-four hours is useful. It is easier for the body to kill out a few germs than a large number, and a disinfection of the wound that kills even a part of the germs is a great help. An animal that has bitten any one should not be killed, but should be shut up until it is known whether or not it has rabies. If the animal remains in health for nine or ten days, there will be no occasion for worry. If it shows symptoms of the disease, it should be killed without injuring the brain, and the head should be sent to a Pasteur Institute or to a bacteriological laboratory. There the brain can be examined for the germs of rabies, and if they are found, it will be certainly known that the treatment should be begun at once.

FIG. 89. The germ of dysentery. The dark bodies in the germ are red blood corpuscles on which the germ feeds.

DYSENTERY

As we have already learned (page 81), acute dysentery is caused by a bacillus that is closely related to the typhoid germ. There is a chronic form of dysentery, however, that is caused by a protozoön. This germ is much larger than most disease germs, and in many ways it resembles a large white blood corpuscle. The germ of dysentery lives in impure water, and when swallowed, grows in the large intestine[1] and causes the

[1] Dysentery germs are abundant in the discharges from the bowels of

disease. Like typhoid fever and some other diseases, dysentery comes chiefly from water, and the way to prevent it is to drink only pure water. Chronic dysentery is more common in the southern than in the northern states, but cases of it occur in all parts of the country.

MEASLES

Measles is a very infectious disease even in the early stages. The discharges from the nose and throat of a patient are especially dangerous, and the germs may be carried on clothing. In measles the breaking out is not only on the skin but also in the throat and air passages, and great care should be taken to protect a person suffering with measles, or one recovering from the disease, from the germs of colds, influenza, pneumonia, and consumption. The eyes also need special care during this disease, or they may be weakened for life. The incubation period is from seven to twenty-one days.

Measles is a far more serious disease than is generally supposed. Not only does it cause many deaths, but often it weakens the body so that it falls an easy prey to other diseases. There is no reason why this disease should be allowed to run uncontrolled, as it does. In measles, as in other severe infectious diseases, quarantine should be strictly enforced and disinfection should be thoroughly carried out. A patient is dangerous as long as the discharges from the eyes and nose continue, usually for a period of about three weeks from the break-

any one who is sick with the disease. It is therefore very important that these discharges should be carefully destroyed (page 161), so that the germs may not be carried about by flies or in other ways.

ing out of the rash. In a house the germs die out in about two weeks.

GERMAN MEASLES

This is a different disease from ordinary measles, and one that is less severe. The incubation period is from two to three weeks.

CHICKEN POX

Chicken pox is a mild disease that seldom attacks any one but children. It is of importance mainly because mild cases of smallpox are often mistaken for it. The incubation period is from thirteen to eighteen or nineteen days.

SCARLET FEVER

Scarlet fever is a highly infectious disease. The germs withstand drying for months. They may be carried through the air, and in general are spread in the same ways that the germs of smallpox and measles are scattered. Scarlet fever affects children especially. It is a difficult disease to control because it is very infectious, and because some mild cases of it are not recognized. These mild cases, however, may give rise to the most malignant type of the disease, and should be carefully quarantined. Kidney trouble, an attack on the middle ear or some other part of the body by pus-forming bacteria, and other bad after-effects often follow scarlet fever. The incubation period is usually from two to five days, but may be much longer. The discharges from the nose, throat, and ears, and the scales from the skin, are especially dangerous.

PROTOZOAN DISEASES OF ANIMALS

Protozoa cause many diseases of animals. Texas fever, or "tick fever," a very severe disease of cattle in the southern part of the United States, is due to a protozoön in the blood. This germ is carried from one animal to another by a kind of tick. Nagana is an African disease of animals, the germ of which is carried by a fly. This disease kills all horses and cattle over a large area in central Africa, and makes travel and agriculture very difficult in that region. Surra is a protozoan disease that is fatal to great numbers of horses and cattle in India and other parts of southern Asia, in the East Indies, and in the Philippines. This disease is spread by the bites of flies. Protozoa are found also in the blood of rats; and birds, turtles, frogs, and many other animals are infected with them.

POINTS TO BE REMEMBERED

1. Rabies is probably caused by a protozoön that attacks especially the brain and spinal cord.
2. Almost all the rabies in our country comes from dogs, and the disease can be stamped out by properly muzzling dogs.
3. The Pasteur treatment will usually prevent rabies from developing, if treatment is begun in time.
4. A wound made by the teeth of an animal should be carefully disinfected.
5. Chronic dysentery is a protozoan disease and usually is contracted from polluted water.
6. Measles and scarlet fever are severe infectious diseases and should be carefully quarantined.
7. Protozoa cause many other diseases of man and animals.
8. The germs of many of these diseases are carried by insects.

CHAPTER XXVII

INTESTINAL WORMS

INTESTINAL worms are in no sense germs, for their bodies are composed of many cells, and some of them are animals of considerable size. Yet we shall briefly discuss some of the more important of them, because they afflict more people than is generally known, and because by proper sanitation they can be avoided. How important this subject is may be known when it is learned that in some tropical countries almost the whole population is infected with these worms, and that in countries like Germany examinations have frequently shown that from 30 to 50 per cent of the people of a community were infected with intestinal worms of one kind or another. The subject has not been thoroughly studied in the United States, but examinations made indicate that intestinal worms are much more frequent in the southern than in the northern states.

EELWORMS

Eelworms (*Ascaris lumbricoides*) are large yellowish white worms, thicker than a lead pencil, and sometimes over a foot long. Examinations in other countries have proved that from 10 to 40 per cent of the people are infected. They are probably less frequent than this in the United States, but many people, especially children, suffer from these worms. The eggs develop in the soil into small worms, and it is probable that these are usually swallowed in water. The way to check the

spread of these worms is to prevent the pollution of the soil, for the eggs that cause the trouble are spread only by infected human beings.

PINWORMS

The pinworm (*Oxyuris*) is a small white worm that grows mainly in the lower part of the large intestine. The disease is most common in children. The eggs are often on the hands of infected children; they may get into drinking water; or children, by playing in polluted soil, may get the eggs on the hands and into the mouth. Children that are infected should be treated, or they will infect others, and the soil about wells and houses should be kept free from pollution.

WHIPWORMS

The whipworm (*Trichuris*) is a slender white worm nearly two inches in length. The eggs get into the body by being swallowed. In some parts of Europe from 10 to 30 per cent of the people are infected, and it is known that the disease is not at all uncommon in the United States.

HOOKWORMS

The hookworm (*Uncinaria*) is the most important of all the intestinal worms. It is a slender white worm not quite half an inch in length. These worms grow in the small intestine in great numbers. They are found in the warmer parts of all the continents. In Porto Rico they infect 90 per cent of the country people, and cause one fourth of all the deaths in the island. In the Philippines it is thought that more than half the people are infected with hookworms, and in the United States, south of the Potomac River, hundreds of thousands of

people (probably over two millions) have hookworm disease. These people are so weak that they are unable to do their work, and in severe cases death may occur.

FIGS. 90 and 91. Hookworm victims. (*After photographs by Dr. Charles W. Stiles, U. S. Public Health and Marine-Hospital Service.*)

How hookworms get into the body. The eggs of hookworms pass out of the alimentary canal, and if they are allowed to get into the soil, will develop into very tiny worms. These small worms may enter the body through the skin (causing "ground itch," "toe itch," or "dew sores"), make their way to the lungs, crawl up the trachea to the mouth, and reach the intestine by being swallowed. It is possible that they may also be taken into the intestine in water, or in food that is eaten with soiled hands. The worms do not multiply in the intestine, but they are known to live for more than six years and they probably live as long as ten years.

Hookworm disease. Hookworms poison the body with toxins and cause a marked anemia (lack of red blood corpuscles). The disease may be mistaken for malaria, or very often the hookworm victim is considered lazy and shiftless, and it is not realized that he is in a diseased condition. The symptoms of the disease are pale-

ness, thinness, dull skin and eyes, dry hair, continued weakness, and sometimes an appetite for such substances as earth, tobacco ashes, paper, and plaster. Hookworm disease is one of the easiest of all diseases to cure, for the worms may readily be killed by a few doses of very cheap and simple medicines.

Where hookworm disease is most common. Hookworm disease is most common on light and sandy soils (the kind of soil on which pine trees grow). It is more common among children than among adults, because children go barefooted, and sometimes eat with unwashed hands after playing in the earth; it is more common among agricultural laborers, brickmakers, and railroad laborers than among those who do not come in contact with the soil; and the disease is more severe (though not more common) in the white than in the colored race. In some sections of our country nearly all the poor white people have severe hookworm infection, and it is hopeless to expect any progress among these people until they are cured of their disease.

The prevention of hookworm disease. The eggs of hookworms get into the soil only from persons who have the disease. Away from the air, or in very wet soils, the eggs die, and the disease can be entirely prevented by the use of closets. Great care should therefore be used to prevent the pollution of soils about houses. To a great extent children may be saved from infection by the wearing of shoes; but keeping the soil free from pollution is the important measure in the prevention of hookworm disease.

Weakness caused by intestinal worms. In our southern cotton mills many of the workers have anemia.

This anemia is caused by hookworms, and not by inhaling the lint from the cotton, as is often supposed. These persons fall ready victims to tuberculosis and other diseases, and the death rate among them is very high. The best example, however, of how intestinal worms weaken the germ-killing power of the body comes from the Philippine Islands. In the prison at Manila there were about 4000 prisoners. Most of them seemed to be in fairly good health, but prisoners died of diseases from which they should have recovered, and in spite of all the care of the authorities, the death rate was very high (about 70 a year for each 1000 prisoners). An examination with the microscope showed nearly all the prisoners to be infected with intestinal worms, and medicines were given to kill the worms, and after that the death rate in the prison was little more than one sixth of what it had been before (falling to 12 a year for each 1000 prisoners). These facts show clearly that intestinal worms lower the resistance of the body to disease germs.

Preventing the spread of intestinal worms. Persons who are infected with intestinal worms should be treated with medicines to kill the worms. This will not only restore them to health, but will stop the supply of eggs that infect others. In Porto Rico, during one year, the government treated 89,000 people for hookworms, and it hopes to continue the work until the disease is stamped out. In the United States no general effort has been made to aid the victims of this disease, but it is hoped that this work will be undertaken soon.

The second great step in the prevention of the spread of intestinal worms, and the step that is most easily put

in operation, is to build closets to receive the wastes from the alimentary canal, and stop the pollution of soils about houses. This precaution alone will not only almost entirely prevent the diseases that are caused by intestinal worms, but it will in a great measure prevent the spread of intestinal diseases that are caused by germs. It is to be remembered that many persons who themselves show no signs of ill-health may be infected with intestinal worms, and all soil pollution about houses should be stopped.

POINTS TO BE REMEMBERED

1. Intestinal worms are far more common than has been generally supposed.
2. The young of the eelworm develop in the soil and are swallowed in water.
3. Pinworms may be spread by the hands or by water.
4. Whipworms are swallowed in water.
5. A large number of people in the southern part of the United States are infected with hookworms.
6. Hookworms cause great weakness, and even death.
7. The eggs of the hookworm develop in the soil, and the young worms get into the body either by passing through the skin or by being swallowed.
8. Hookworms get into the soil only from infected persons.
9. The disease can be prevented by preventing soil pollution.
10. Intestinal worms weaken people and cause them to fall easy victims to other diseases.
11. Persons with intestinal worms should be treated to kill the worms and stop the supply of eggs, and soil pollution should be most carefully guarded against.

CHAPTER XXVIII

THE IMPORTANCE OF SANITATION

Suppose that on a certain day in every year all the people in a village of a thousand inhabitants had to march past a bag in which there were a thousand balls, and each person had to draw a ball from the bag. Suppose that in the bag there were as many white balls as there were persons in the village who would escape all germ diseases during the next year, and as many balls of various colors as there were persons in the village who during the next year would be attacked by germ diseases. Suppose also that as many of these colored balls were marked with black crosses as there were persons in the village who in the next year would die of diseases caused by germs. In an average American village, then, there would be in the bag two or three red balls for those who were marked for tuberculosis, three or four green balls for the victims of typhoid, perhaps six or seven blue balls for those selected for pneumonia, and a great number of other balls of various colors for those who must suffer from some serious infectious disease, such as diphtheria, meningitis, influenza, whooping cough, measles, or scarlet fever. There would also be in the bag some eight or ten balls marked with the fatal black cross, which meant that before the year was done whoever drew that ball would die because of germs.

If all the people of a town had to go through a drawing like that described above, would there not be a great fear in the heart of every one lest he or some one whom he

loved should draw the wrong ball? And if some one should come to the village who could show the people how to arrange matters so that there would be only a few colored balls, and almost no balls with black crosses in the bag, would not the people help him and encourage him in every way? We are sure that they would gladly give him the money that he needed in his work, and that they would assist him as much as was in their power.

FIG. 92. Louis Pasteur. He discovered the Pasteur treatment for rabies and did more than any other one man to make clear to us the nature of germ diseases and to point out ways by which these diseases can be prevented.

The danger from germ diseases in the average American town. In the average American town the people are in the same danger from germ diseases that they would be in if they had to go through a drawing of lots like the one described above. This you can readily believe after your study of former chapters of this book. In every town a certain number of people are stricken with infectious diseases each year. Each year we hope that neither we ourselves nor any one who is dear to us will be the victims of the germs, but who they will be it is never possible to tell. Victims there will certainly be, for neither by day nor by night do our small enemies rest, and year by year they take their toll from every village in the land.

Our defenders from the germs. From the beginnings of history, man has been attacked by unseen foes, slain by hands that were invisible. In the last thirty years our enemies have been found out, their homes have been discovered, their ambuscades have been torn down, and the paths by which they reach us have been traced out. We have now physicians and health officers who can tell us how to escape most of the germs that attack us. They have come to show us "how to arrange matters so that there will be very few colored balls and almost no balls with black crosses in the bag." Shall we work with these persons who can in great measure defend us from the germs that would attack us, or shall we refuse their aid and allow the germs to ravage and destroy, as they have done ever since man has lived upon the earth? This is the question that each community is now being asked to decide.

FIG. 93. Robert Koch. In 1876 by experimentation he proved beyond doubt that disease can be caused by a germ. He discovered the bacillus of tuberculosis and was one of the great leaders in the warfare against germs.

Sanitation. Sanitation comes from a Latin word (*sanitas*) that means wholeness, or health. It is the science of how to preserve the health, especially the public health. To have our premises clean and free from flies and mosquitoes, our milk and water supplies pure, and the air we breathe free from disease germs, is sanitary. To live among insects, dirt, and germs, to drink

impure water and unclean milk, and to breathe in germs from the bodies of persons who are diseased, is unsanitary.

It is of interest to note that from the same Latin word from which *sanitation* comes, we get also our words *sanity* and *saneness* (soundness of mind), and *insanity* (unsoundness of mind). *Sanity* and *sanitation* mean the same in their origin, and we might conclude that to practise sanitation is to act sanely and sensibly, while not to practise it is to act in a way that indicates either a lack of knowledge or a lack of wisdom. Certainly (since every one is anxious to escape disease) we should not be far from the mark if we spoke of a town that was clean and free from dangerous germs as a sensible, sound-minded town, and of a town in which the people lived amid dirt and germs as a foolish town. In former chapters of this book we have discussed the importance of keeping down dust, of having pure water supplies, and of destroying mosquitoes. We shall now study other measures that may be employed in making our homes and communities sanitary places in which to live.

POINTS TO BE REMEMBERED

1. Every year in every town a number of persons are attacked by disease germs.
2. Most cases of germ diseases can be prevented.
3. Physicians and health officers can tell us how to escape these diseases.
4. It is sensible to practise sanitation, and as far as possible avoid germ diseases.

CHAPTER XXIX

THE HOUSEFLY

THERE is a belief among some people that flies are useful because they feed on wastes. No greater mistake could be made. Flies light on and walk over all manner of unclean matter, and then spread germs and uncleanness over dishes, food, and milk vessels. They may come to our faces straight from feeding on the sputum of a consumptive or the wastes of a typhoid patient. They may fly directly from some one who has sore eyes to our hands or faces or to the very eyes of a little baby that cannot defend itself from them. There is nothing more dangerous or more unclean than to live among a swarm of flies.

Kinds of germs carried by flies. Almost any kind of germ may be carried by flies. Not only do they carry germs on their feet, but when a fly feeds on matter that contains disease germs, the germs are found in the matter that comes from its alimentary canal. In one speck left by a fly that had been captured on the face of a leper, 1115 leprosy germs were found. Tuberculosis germs and typhoid germs have also been found in fly specks, and there is no reason why a fly that walks over or feeds on matter containing the germs of any disease should not spread abroad those germs.[1]

[1] Flies caught in the market house in Nashville, Tennessee, were found to be carrying from 1000 to 10,000 bacteria each. Colon bacilli were carried by 64 per cent of the flies, and staphylococci or streptococci by 24 per cent of them.

Keeping germ-containing matter away from flies. A fly may get germs on its feet by walking on the skin of a patient who has smallpox, measles, scarlet fever, or

FIG. 94. This child is healthy and well, but flies may leave disease germs in his food.

erysipelas. It may easily take up dangerous germs from an open sore or ulcer. Flies are certain to become infected if they are allowed to feed on the sputum of a consumptive, pneumonia, influenza, or diphtheria patient.

The wastes from typhoid, dysentery, and cholera infantum patients must be absolutely destroyed, or flies may carry the germs all over the vicinity and may endanger the life of every one in the neighborhood. In general, it is unsafe to have flies about any person sick with an infectious disease, for there is always danger that by lighting on his hands or face, or on some article in the room, they will take up germs.

Screening against flies. From what you already know you will realize the importance of screening against flies, of freeing our houses as much as possible from them by the use of fly paper and other means, and of covering all food and dishes from flies. When any flies at all are in a house, a young child should always be screened from them, for it is not right to leave a helpless little baby where it will not only be continually annoyed by flies crawling over it, but will have many different kinds of dangerous germs left on its face.

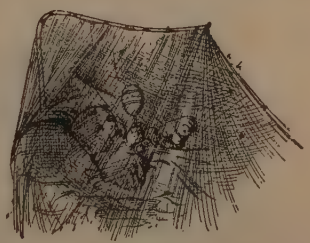


FIG. 95. A baby should be screened from flies.

Removing the breeding places of flies. It is possible to do much in the way of avoiding danger from flies by using screens and fly paper, by covering food and dishes, and by removing all materials that attract them to the house. A far easier and more effective way is to remove the breeding places of the flies. The egg of the housefly is laid in manure (chiefly horse manure) about stables, in the matter in dry closets, or occasionally in garbage or decaying vegetable matter. In a day or less the egg

hatches into a small, white, footless maggot, which in nine or ten days from the time the egg was laid changes into the adult fly.

It is estimated that in one summer three hundred flies may hatch in a cubic inch of manure, and if the breeding places of the flies are left undisturbed, they will hatch faster than it is possible to kill them. It is a simple matter, however, to stop their increase by removing, once a week, all matter in which they breed, burying it, or spreading it on the fields where it will dry and the

FIG. 96. The life history of the fly. *A* shows the eggs; *B*, the larva or maggot; *C*, the pupa, and *D* the adult fly.

eggs and young of the fly will be killed. They can also be prevented from breeding by keeping manure carefully covered so that the adult flies cannot get to it to lay the eggs. Where only one or two animals are kept, this may be done by throwing the manure into a covered box or barrel until it can be removed.

The economy of fighting flies and mosquitoes. Under ordinary conditions it is not expensive to remove the breeding places of flies and mosquitoes in a town, and no money that a town can spend will pay better, either

in dollars and cents or in the comfort that will come to the inhabitants, than money that is spent to free a town

FIG. 97. In a manure pile like this, millions of flies will breed.

from these insects. In a small town one man can easily look out for all breeding places of mosquitoes. This will mean that there will be no malaria in that town; and there are many small towns that would have been large cities long ago if they had been free from malaria. A town cart can remove weekly all the matter in which flies breed, and this matter can be sold for fertilizer for almost enough to pay for the expense of removing it. Boards of trade often try to improve and advertise their towns. Suppose a board of trade could say: "In our town you will not be bothered by mosquitoes, and neither you nor any member of your family will have malaria.

You will not be annoyed by flies, and you need not fear that while you are looking the other way a fly will leave typhoid germs on your plate." Would not a board of trade that could truthfully say this about its town have some facts to present that would interest persons who were seeking new homes?

POINTS TO BE REMEMBERED

1. Flies are very unclean and can carry almost any kind of disease germs.
2. Flies should not be allowed about sick people or about the wastes from the sick.
3. Flies breed in manure and in other waste matter, the egg hatching into a maggot and the maggot turning into a fly in about ten days.
4. Fly screens and fly paper should be used, but the best way of fighting flies is to remove the breeding places.
5. It is economy to fight mosquitoes and flies, and a town that is free from them has many advantages over towns that are overrun with them.

CHAPTER XXX

DISEASE GERMS IN FOOD

Foods (excepting milk) do not contain disease germs so often as does water, but when foods become infected they are particularly dangerous, because germs can multiply in them. To appreciate this point you must understand that it is far more dangerous to take a large number of disease germs into the body than it would be to take a few germs of the same kind. A few dozen or a few hundred of almost any of the ordinary disease germs have no power to harm a rabbit when they are injected into its body, but if the dose is increased to several million germs, often the rabbit will die. Its white corpuscles and germicidal substances have the power to kill a few germs, just as the soldiers in a fort can drive away a small company of besiegers who are trying to break down the front gate of the fort. But when millions of germs attack the body at once, the defenders of the body cannot overcome them, just as the defenders of the fort would be unable to resist successfully a great multitude of attackers, who would not only try to enter through the front gate, but at the same time would break down all the other gates and swarm over the walls at every point. It is because in many foods a single germ can increase to a multitude that our foods especially need to be guarded against infection.

How germs get into foods. Not only the germs of intestinal diseases but also the germs of such diseases as tuberculosis, pneumonia, diphtheria, and scarlet fever,

may reach the mouth in food. These germs get into the food from flies, from dust, from washing in impure water

FIG. 98. Food that has been handled by the public is likely to contain germs.

the food or the vessels in which food is kept, from diseased animals, and most commonly of all from the hands of those who are carrying germs. Those who prepare food should pay special attention to the cleanliness of their hands, washing them often with soap and water (page 161), and no one who is sick with an infectious disease or who is just recovering from such a disease, should have anything to do with the handling or the preparation of foods.

Danger from spoiled food. Besides the germs of special diseases, there are always present in foods the bacteria that cause fermentation and decay.[1] These germs do not

[1] If foods are cooked sufficiently to kill all bacteria in them (spores as well as the growing forms of the bacteria), and then sealed away from germs, as is done in cans, they may be preserved for years without decay. Strong salt solutions (brine) will also preserve foods, and strong sugar solutions, such as are used in preserving, will prevent the growth of germs in food.

ordinarily cause sickness in man, but when taken into the alimentary canal in the prodigious numbers in which they are found in foods that are beginning to spoil, they cause fermentation in the intestine, diarrhœa, and other troubles. Tainted and soured foods are therefore unsafe and should never be eaten.

Buying foods. The wise person buys his food in a store that is kept clean and where the food is protected from dust and flies. He never buys old and tainted meats or fish, or overripe or decaying fruits or vegetables, for these are swarming with germs, and are already unfit for use. Above all, he will not buy any food that has been fingered over and handled by the public, for there is always danger that on such foods disease germs have been left from the fingers of some sick or germ-carrying person.

The care of foods. In the care of foods two points are of especial importance. These points are *cleanliness* to prevent germs from getting into food, and *cold*, to keep germs that do get into the food from multiplying. The importance of cooking to kill any disease germs that may be in foods, as well as to kill certain worms that may be in meats, will of course be understood. It should also be understood that by thorough cooking all germs of every kind in food may be killed, and that food may be preserved in this way until a new supply of germs has time to grow.

Dangers from milk. Of all foods that are used by man, milk is the most dangerous, because without any cooking it furnishes a splendid place for the growth of almost all kinds of germs. Tuberculosis is sometimes contracted from milk, and it is known that typhoid fever,

scarlet fever, and diphtheria may be spread by milk. Again and again it has been found that along the route of a certain milkman the people were suffering from one of these diseases, and on investigation it would be proved that a case of the disease existed among those handling the milk or in their families; or that the bottles had been taken back from families where the disease was; or, in epidemics of typhoid fever, that the milk vessels had been washed in water from wells containing the typhoid germ. One article in a medical journal reported 330 epidemics traceable to milk, of which 195 were typhoid epidemics, 99 were epidemics of scarlet fever, and 36 were diphtheria epidemics. No person who has consumption, or who has recently recovered from typhoid fever or other germ disease, should have anything to do with the milking of cows or the handling of milk. In general, the safest milk is that which is bottled at the dairy where it is produced. If possible, milk should be secured from a dairy that is known to collect and bottle its milk under sanitary conditions. It is difficult for a private citizen to guard himself against dangers from milk, and in all well-governed cities and towns a health officer looks after the milk supply.

Milk and cholera infantum. Most cases of cholera infantum are due to germs that are in milk.[1] Sometimes, as we have already learned (page 84), it does not seem to be any one special germ that is causing this disease, but the enormous number of many different kinds of bacteria that are in the milk in hot weather. The heat

[1] Of 9111 infants that died in Berlin, Germany, during 1906, only 844 were fed entirely on their mothers' milk.

weakens the babies and leaves them unable to resist these multitudes of germs. Only pure milk is a fit food for babies, and milk that is filled with a multitude of germs and their poisonous toxins is unsafe. Especially in the months when babies are weakened by heat is a pure milk supply important.

FIG. 99. Dairies should be models of cleanliness.

Keeping milk free from germs. All milk vessels and feeding bottles for babies should be thoroughly scalded before using to kill the germs in the milk that adheres to them. Otherwise these germs will multiply in the new milk, and soon it will be filled with them (page 18). Milk vessels should never be rinsed in any but boiled water, the purest of rain water, or artesian water, for one dangerous germ that gets into the milk from the water remaining on the vessels may grow into a mul-

titude. Milking should be done in a clean building that has fly screens on it, and everything possible should be done to keep dust and hairs out of the milk, for these are loaded with germs. The milk should be cooled as quickly as possible, and kept cool to prevent the germs that do get into it from multiplying. It should be used before it becomes old, for milk that at first has only a moderate number of germs in it may soon be filled with countless myriads of them. It is also necessary for a medical officer to examine the cows from which the milk comes, or there will frequently be living tuberculosis germs in the milk (page 59).

Killing germs in milk. When it is impossible to obtain pure milk, it is often best to "Pasteurize" the milk before it is used. This is done by heating it to 170 degrees for a few minutes, or to 155 degrees for half an hour. This will kill all disease germs in the milk and nearly all the other bacteria, and the person who uses the milk will have fewer germs to resist. A few children do not digest Pasteurized milk as well as they do raw milk, and Pasteurizing old milk that is already filled with acids and toxins from the bacteria that are swarming in it will not make this milk a fit food for a little child. In summer, however, most of the milk sold in cities is greatly improved by Pasteurization, and it is of no small advantage that all the tuberculosis, typhoid, and other dan-

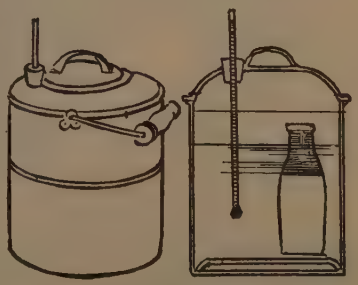


FIG. 100. A vessel arranged for Pasteurizing milk.

gerous germs that are in the milk are killed. After milk is Pasteurized, it should be cooled at once, or soon it will be filled with bacteria again.

POINTS TO BE REMEMBERED

1. Infected foods are particularly dangerous because disease germs can multiply in food.
2. Germs can get into foods from flies, dust, impure water, and from the hands of persons who are carrying germs.
3. Spoiled foods are unfit for use.
4. Foods that have been handled by the public, or exposed to flies or dust, should not be purchased.
5. Cleanliness and cold are the points to be emphasized in caring for foods.
6. Impure and unclean milk is the most dangerous of all foods; tuberculosis, typhoid, scarlet fever, and diphtheria may be contracted from it.
7. Cholera infantum is usually caused by unclean or old milk.
8. Milk vessels should be carefully scalded and should be rinsed only in pure water.
9. Milk should be collected in as cleanly a manner as possible and cooled quickly to prevent the multiplication of germs in it.
10. When milk contains many bacteria, it is sometimes advisable to Pasteurize it before giving it to a little child.

CHAPTER XXXI

DISINFECTION

It cannot be too strongly emphasized that nearly all the germs that cause disease in man come from persons who have germ diseases, and that insects, dust, water, and food are dangerous only when they have become infected with germs from some human being. In preventing the spread of infectious diseases, therefore, the most important point is to destroy the germs that come from the bodies of the sick.

Light. Light is destructive to bacteria, and bright sunlight kills many kinds of germs in a few minutes. It is an excellent practice to expose bedclothes and rugs to the sun, and to throw up the shades and allow the sunlight to enter the house. In rooms occupied by consumptives or by pneumonia, diphtheria, or influenza patients, this is especially important.

Drying. Drying checks the growth of all germs, and most germs die if they are thoroughly dried. Damp houses keep alive the germs that are in them, and consumption, pneumonia, and other diseases are more likely to develop in damp than in dry houses. Dirt and dust, mingled with sweat and oil from the skin, on doorknobs, banisters, and furniture, protect germs from light and keep them alive. For this reason the doorknobs and desks in schoolrooms should be cleansed occasionally with soap and hot water.

Heat. Boiling water kills the germs of all common diseases, and handkerchiefs, dishes, and clothing that

have become infected can be made safe again by thoroughly boiling them. Sputum and articles of little value may often be most conveniently disposed of by burning (page 56). The surfaces of dishes contain tiny crevices in which germs lodge, and in disinfecting dishes with hot water, it is necessary to leave them for a few minutes in water that is boiling, so that the heat will reach the germs in the crevices.

Chemical disinfection. Certain chemicals are so poisonous to germs that they are extensively used in disinfecting. A physician should always be consulted as to which disinfectant is best for a particular purpose, and exactly how to use it, for some of them are better for one purpose than for another. Most disinfectants are very poisonous, and a little red ink or other coloring matter should be added to them so that they will not be mistaken for water. The following are some of the most common disinfectants: —

Bichlorid of mercury (corrosive sublimate) dissolved in water, with one part of the bichlorid to a thousand parts of water (1 ounce to 8 gallons of water), kills nearly all kinds of germs in two or three minutes. This disinfectant can be purchased in tablets of the right size to make a pint or half a pint of the solution. For the hands, for washing floors and furniture, and for disinfecting clothing that can be soaked in it, this is an excellent disinfectant. It cannot be used on metals, as it destroys them, and it is not good for disinfecting where there is much organic matter present, as there is in discharges from persons sick with typhoid or other intestinal diseases. It is very poisonous.

Biniodid of mercury is more than twice as powerful as

bichlorid of mercury, and need be made only half as strong. It is one of the best general disinfectants, and is especially useful in disinfecting the hands, since it does not injure the skin. It can be used on metals, and is useful for disinfecting instruments.

Carbolic acid, made up in a $2\frac{1}{2}$ per cent solution ($3\frac{1}{2}$ ounces of liquid carbolic acid to a gallon of water, or seven teaspoonfuls to a pint), is a good disinfectant. For disinfecting sputum and other discharges from the body it is well to use a 5 per cent solution.

Lysol is a stronger disinfectant than carbolic acid. It often destroys the colors in clothing. For sputum it is one of the best disinfectants.

Chlorid of lime, used in the proportion of 4 ounces of chlorid of lime to 3 gallons of water, is a cheap and powerful disinfectant. It may be purchased in grocery stores, put up in tin cans under the name of bleaching powder. It cannot be used on colored clothing, and the solution must be freshly made.

Milk of lime is a powerful disinfectant. To make the solution, add one part of freshly slaked lime by weight to four parts of water; or add the hard lumps of quicklime to the water and stir until a thick whitewash is formed. This is a cheap disinfectant, and for disinfecting the body wastes it is as good as anything that can be used. It should not be used in sinks, for it will cause trouble with the traps. Air-slaked lime (lime that has crumbled into fine powder from contact with the air) is worthless, and only quicklime should be used.

Special points in disinfecting. In caring for a case of infectious disease it is well to understand the following special points in disinfection: —

Disinfecting the hands. Any one who is caring for a person sick with an infectious disease should frequently sterilize his hands by holding them in a disinfectant. Washing the hands thoroughly in a soapy lather will almost free them from germs, and before eating they should be washed in this way and then disinfected. Keeping the nails trimmed and the skin smooth makes the hands much easier to disinfect. The hands of a person who is sick with a germ disease should frequently be washed with soap and water, and should be disinfected occasionally.

FIG. 101. Washing the hands thoroughly with soap and water helps to free them from germs.

Disinfecting the body wastes. In typhoid fever and dysentery, the discharges from the intestines and kidneys should be received in vessels containing disinfectants. A strong solution of either chlorid of lime or milk of lime is excellent for this purpose. It is necessary to see that the disinfectant is thoroughly mixed with the waste matter, and it should be allowed to stand for several hours to make sure that all germs are killed. Any matter that is vomited by the patient may contain the germs, and should be treated in the same way as the intestinal and kidney discharges, and all handkerchiefs that a patient may use should be put into hot water or a disinfectant. The wastes from the alimentary canal should be disinfected in consumption and other respiratory diseases as well as in intestinal diseases. Even

where there is water sewage and these wastes can be thrown into the closet with little danger to the family of the sick person, still they ought to be disinfected; for the germs may reach the water supply of another town, and some one may suffer from them.

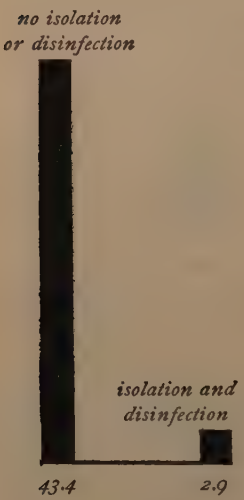


FIG. 102. In Michigan, from 1890 to 1903, there were on an average 43.4 cases in each outbreak of measles, where isolation and disinfection were not practised; in each outbreak where these measures were put in force, there were, on an average, only 2.9 cases. (From report of Michigan State Board of Health.)

Disinfecting in diseases where germs are in the nose and mouth. In diphtheria, pneumonia, consumption, influenza, measles, scarlet fever, and epidemic cerebro-spinal meningitis, the germs are in the discharges from the throat and nose. The instructions given on page 56 for disinfection in cases of consumption, apply in all these diseases.

Disinfecting buildings. Where a room or whole house is to be disinfected, it is usually done by fumigating. Formaldehyde is best for this purpose. Special directions are necessary for this work if it is to be done effectively. Quicklime is a good disinfectant for cellars and closets.

Mistaken ideas in regard to disinfection. It is a common idea that there is some connection between the smell of a substance and its power as a germ-killer. Strong-smelling substances are therefore sometimes burned in sick rooms, or a little carbolic acid is exposed

in a saucer so that it will scent the air of the room. It need hardly be pointed out that germs are not injured by anything of this kind.

The importance of disinfection. Our second great law for the prevention of germ diseases was to keep germs from the bodies of the sick from being scattered abroad. This can be done only by disinfection, and if all families would learn the value of disinfection and practise it, perhaps the most important step in the prevention of germ diseases would be taken.

Isolating the sick. People need to learn that sick persons should be kept away from those who are in health. This is best for both the sick and the well. It is possible to practise disinfection efficiently only when a sick person is kept in a room by himself, and the careless visiting in sick rooms which is allowed in colleges, boarding schools, and most families, is a cause of much disease. Figure 102 shows how effective isolation and disinfection are in checking the spread of measles, one of the most infectious of all diseases.

POINTS TO BE REMEMBERED

1. Disease germs come from the bodies of diseased people.
2. Light and drying kill germs.
3. Heat is an excellent disinfectant.
4. Certain chemicals poison and kill germs.
5. A physician should be consulted as to the best disinfectants to use for particular purposes.
6. There is no reason to think that a substance is of any value as a disinfectant because it has a strong odor.
7. Disinfection and isolation are very important measures in checking the spread of germ diseases.

CHAPTER XXXII

UNHYGIENIC HABITS

As we have said again and again in former chapters, nearly all disease germs leave the body by way of the mouth and nose, or in the wastes from the alimentary canal and kidneys, and most of them get into the body through the mouth and nose, especially through the mouth. In their daily life, many persons have fallen into certain habits that make it easy for germs to get into the mouth and nose, and into other habits that scatter germs abroad where they are likely to do harm.

FIG. 103. It is never safe to use public drinking cups.

Putting objects into the mouth. The habit of putting

into the mouth pencils, coins, candy, chewing gum, or any other object that has been in the mouth of another person, gives germs an opportunity to pass directly from one mouth to another. A public drinking cup on a train, at a public fountain, or in a school, is certain to be used by some one with disease germs in his mouth.[1] If another person then drinks from the cup, the germs have as good an opportunity as a germ could wish to pass into the mouth unweakened by drying. Each pupil in a school should have his own cup, and a private cup should always be carried when traveling; but if it is necessary to drink from a public cup, it is best to put both lips into the cup while drinking. This is because the germs are more likely to be sticking to the edge of the cup (in mucus from the lips of persons who have previously used the cup) than to be floating free in the water.

FIG. 104. Rubbing the eyes and putting the hands to the face are bad habits.

Putting the hands to the face. Another habit that we would mention is that of allowing the fingers to touch the face, eyes, or lips. In many ways — from books, doorknobs, pencils, seats, and straps in street cars, and from the hands of other persons — we get germs on our hands. It is advisable, therefore, to form the habit of keeping the hands away

[1] One investigator found 20,000 bacteria on a drinking glass that had been touched by the lips, and 5000 bacteria on a glass slip touched, as the leaves of a book are often touched, by a finger moistened with saliva.

from the face. Especial attention should be given to this point when sore eyes are prevalent. Before eating, the hands should be thoroughly washed with soap, for this is a very wonderful remover of germs.

Exchanging books in the schoolroom. Where schoolbooks are furnished by the town or state, they are sometimes given out each morning, and it is only by chance that a pupil receives the same book on two successive days. This is not right, for the germs of diphtheria, pneumonia, scarlet fever, and of other dangerous diseases may be spread through a school by the books. Each child should keep the same books throughout the year, and passing books about from one pupil to another should be discouraged. It might be added that writing paper is more sanitary than the slates that are still in use in some places, for slates are often wet with saliva, and the sponges that are used on them are generally reeking with germs.

Drinking water to which one is not accustomed. When one is away from home on a short journey (as on a visit to a city or to an exposition), it is often not possible to be sure whether the water that is provided for drinking purposes is safe or not. It is, therefore, the part of wisdom to take a supply of water from home, or to drink mineral water or boiled water, or even tea or coffee. By drinking water from various sources, while on their vacations, hundreds of people every summer contract typhoid fever. Strangers coming into a place that has an impure water supply are always far more liable to contract typhoid fever than the inhabitants of the place, who are accustomed to the water, and almost any strange water is likely to cause intestinal disturbances

that may spoil all the pleasure of a short visit or excursion.

Spitting. In a previous chapter (page 72) we have spoken of the way disease germs are scattered about by spitting. That this must be the case as long as people continue to spit, any one must understand. Tobacco spit is as bad as any other kind of spit, and every one must learn that to spit at all is not only an unclean and disgusting habit, but one that is very unsanitary. Many cities have laws against spitting in public places. These laws are founded on common sense and should be supported by all good citizens. Every one should at least have enough care for others to spit in the gutter and not on the sidewalk, for on the sidewalk the germs are almost certain to be carried on the feet of passers-by and on trailing skirts into houses, stores, and offices.

Washing the teeth in wash basins. Cleaning the teeth in a wash basin will leave any germs that may be in the mouth in the wash basin, and you will readily understand how easy it would be for a few hundred thousand of these germs to get to the mouth of some one else who washes his face in the basin. A bathroom should have a sink over which the teeth may be cleaned, and in cars and public wash rooms some other place than the wash basins should be provided for cleaning the teeth. In a public wash room the safest plan is to turn on the water and wash in the stream as it comes from the faucet.

Scattering the germs of intestinal diseases. We come now to one of the most important and the most difficult of all the questions of sanitation, the question of how to prevent the spread of the germs of intestinal diseases.

It is utterly amazing the way these germs now get scattered abroad, and the more we study the subject the more we realize how unclean a creature man really is; for we must remember that every one of the million of cases of intestinal diseases that occur yearly are caused by germs that have escaped from the human body in the wastes from the alimentary canal and kidneys. In towns and in the country, where there is no water supply, the greatest care must be taken in disposing of these wastes, or disease will surely come from them. Where a city is supplied with water and has a sewer system, it is not difficult for a person or a family to know how to dispose of these wastes; but if the city disposes of its sewage by running it into the nearest stream, the people down the stream will probably suffer.

The danger of polluting soils. In the last few years a very important discovery has been made. This discovery is that it is not an uncommon thing for healthy persons to carry very dangerous germs, and that the germs of all the infectious diseases of the intestine (cholera, typhoid, dysentery, and diarrhœa) may be carried by persons who are not themselves ill (page 79). So many cases of intestinal diseases come from well persons, that it is unsafe to allow the soil about a house to be polluted by the wastes of any human being, whether he be sick or well. If the soil does become infected with dangerous germs, these germs will be carried about by flies, they will be taken by the feet into houses and to well platforms, and sooner or later they will almost certainly be washed in the soil water into wells. Also, the intestinal worms (page 135) that are so great a scourge in the southern part of the United

States are spread entirely through the pollution of the soil. From this it is perfectly evident that no wastes

FIG. 105. Children often become infected with disease germs by playing in unclean places.

from the human body should under any circumstances be allowed to touch the soil of dooryards. Closets where these wastes can be kept from becoming scattered and the germs in them can be destroyed, should be built.[1]

[1] The discharges from the kidneys are dangerous as well as the intestinal discharges, for they very commonly contain streptococci, and they may contain the bacilli of typhoid fever.

Allowing children to play in the dirt. It is the children, more than any other persons, who suffer from germ diseases. One reason, and doubtless the main reason, for this is that children have less resistance to these diseases than have those who have grown up. Another reason is that children crawl and play on the floor and earth where their elders spit, and where all kinds of dangerous germs are left by the feet of those who have walked on the streets or on polluted soil about the house. Babies should not be put down to play on dirty floors or in dirty yards, nor should they be allowed to put objects into their mouths that have been soiled by dropping them in such places. More than any one else little children need to be guarded against germs, and for their sakes, especially, floors and yards should be kept as clean as possible.

POINTS TO BE REMEMBERED

1. Many people have fallen into habits that make it easy for germs to get into the mouth and nose.
2. Putting objects into the mouth, drinking from public cups, allowing the fingers to touch the face and lips, and drinking water from unknown sources, give germs an opportunity to enter the body.
3. Spitting, cleaning the teeth in wash basins, and polluting the soil are practices that scatter disease germs.
4. The disposal of sewage and the prevention of soil pollution are among the most important questions in all sanitation.
5. Children should not be allowed to play in the dirt, for children, more than older persons, suffer from germ diseases.

CHAPTER XXXIII

PUBLIC SANITATION

The wild man of the forest lives to a great extent alone, but civilized people cannot be independent of each other. Civilized people therefore have governments. The advantages of having a government are so many and so great that no person of intelligence can fail to understand them. Many persons, however, fall into the habit of complaining about their taxes, and fail to understand that the government is a great partnership into which all the people have entered for the good of all, and that for no other money expended do they get so much in return as for the money paid to the government. We will therefore turn away for a short time from the study of sanitation while we try to get a clearer idea of the advantages that come from having a government — advantages so plain that they have caused every civilized people that has ever existed on the earth to establish a government.

The advantages of government. Each person who walks the streets of a city cannot hire a policeman to protect him, and it would not be possible for every family to own a fire engine. Every farmer who wishes to drive over the country cannot afford to build roads and bridges wherever he may wish to go, and only a few families have enough wealth to pay the entire cost of a capable teacher for their children. But if each family will pay but a small sum into the public treasury, the government can provide police and fire departments,

look after the roads, and educate the children of all the people. A government is of advantage to the people who live under it *because at a small cost to each person it gives to its citizens many advantages that they could not have in any other way.*

In a city firearms should not be used, and automobiles and wagons should not be driven too rapidly through crowded streets, because if this is done, many accidents are sure to occur. In the country, a farmer should not turn his cattle and horses out on the public road, or they may injure his neighbor's crops. Yet no one person has authority to lay down rules in regard to the way another shall use a gun or drive an automobile or a wagon, and one farmer cannot force another to keep his cattle off the roads. Only a government with authority over all the people can do this, and it is a great advantage to have a government *that can forbid every one's doing those things that are harmful to the welfare of others;* for there have always been and are now in the world many persons who have little regard for the rights of others.

Government a partnership. From the above you will see that in reality a government is a great partnership. Each partner (citizen) is forbidden to do those things that would be injurious to others, and each partner is required to pay a certain sum of money (his taxes) into the public treasury each year. With this money the government hires done those things that are necessary for the welfare of all. One of the first duties of a government is to guard the health of its people, for as long as a community is greatly afflicted with disease, it cannot make much progress and its people cannot have much happiness.

The necessity for public health officials. It is not possible for an individual to protect himself from disease if those about him are carelessly scattering germs abroad. Only some one with authority over all the people can guard the health of a community, and public health officials are absolutely necessary if sanitary measures are to be enforced. Only those who have been specially trained for the work have the skill that is necessary to fight infectious diseases successfully, only those who are paid to do so can give to the work the time and attention that are required to make the fight successful, and only those with authority to do so can compel careless and unclean citizens to live in a sanitary manner. Without health officials certain persons in every community will keep breeding places for mosquitoes, hatch swarms of flies in great manure piles on their premises, spit on the sidewalks and in other public places, neglect to be vaccinated, or go straight out among the people from cases of very dangerous and very infectious diseases. Without officers of the law certain bad citizens always rob and steal, and these citizens must be forced to let the property of others alone. So in matters of sanitation, the ignorant and the careless citizens must be forced to live so that they will not be a source of danger to those about them.

Supporting health officials. No thief thinks well of the policeman who arrests him, and no murderer loves the judge who sentences him to be hanged. So the persons who are compelled to clean up their premises and live so that they will not be a nuisance and a source of danger to their neighbors often become angry with the health officials and try to injure them and hinder

their work.[1] It is therefore the duty of every one to assist and encourage health officials, and we should always remember that they are trying to save us and not themselves from disease. Whatever they do is done for the good of the people over whom they are watching, and no man can claim to be a good citizen if he deliberately hinders one who is trying to save helpless men and women and innocent little children from disease and death. Especially should a man who claims to be a good citizen, stay in quarantine when he is ordered to do so. For deliberately to scatter abroad disease germs is a crime, and the man who does it knowingly deserves to be treated as other criminals are treated.

The economy of public sanitation. Many persons agree that public sanitation is a good thing, but think that the town or state in which they live cannot afford it. These persons do not understand what preventable diseases are costing their communities, or they do not understand political economy. For any man can afford to spend two dollars if thereby he can save ten dollars, and any community that spends money on public sanitation will save far more in the time that has been lost on account of sickness than it spent in trying to preserve the health of its citizens. The typhoid epidemic at Plymouth, Pennsylvania, cost nearly $100,000, and the persons who died in it were earning in wages $18,000 a year. Lawrence, Massachusetts, put in a water filter, and in four months the filter prevented enough typhoid to pay for itself.

[1] The greatest problem of the health official is the influential citizen who insists on his right to live like a hog and be a menace and a nuisance to all his neighbors. — AN AMERICAN HEALTH OFFICIAL.

If the American people would use one half the sum that tuberculosis is costing them each year in fighting the disease, it is probable that tuberculosis would soon cease to exist. A conservative estimate places the cost of preventable germ diseases in this country at $1,500,000,000 a year, and if this money were used in fighting these diseases, most of them would soon be practically stamped out. The United States government appropriated $100,000 to destroy rats around San Francisco, and some persons thought that this was a great sum of money to spend for such a purpose. Yet the rats themselves, to say nothing of the plague that they carry, do six hundred thousand dollars' worth of damage every year in a city like San Francisco, and in the whole country they do fifty million dollars' worth of damage. Many towns everywhere think they cannot afford a public water supply, and yet every few years each one of these towns pays out more than the cost of a water system because of intestinal diseases. One such town the writer knows, a town of about two thousand inhabitants. Every year this town has from twenty to thirty cases of typhoid fever (besides other intestinal diseases) with two or three deaths, and every two years the people of the town spend enough on typhoid fever alone to pay for the water system that they think they cannot afford. Count up the number of cases of typhoid fever, the number of cases of consumption, or the number of persons who suffer from malaria in your town, and see if the people of the town are not acting in a very extravagant manner when they neglect public sanitation. You will certainly find this to be the case.

The common sense of sanitation. In a former chapter

(page 144) we spoke of the sanity of sanitation. At this time we wish to call attention again to the fact that it is foolish to live in a way that we know will lead to disease. It is cheaper to live in a town where the sidewalks are clean, the streets sprinkled, the houses supplied with pure water, the sewage safely cared for, the milk supply clean, flies and mosquitoes banished, and skilled health officers employed to watch for and prevent infectious diseases, than it is to live in an unsanitary town. It is certainly more pleasant to live in a clean than in an unclean town; at least it is more pleasant to be well in a clean town than it is to be sick in an unclean one. The only sensible thing for any community to do, therefore, is to have public sanitation, and free itself as much as possible from germ diseases.

POINTS TO BE REMEMBERED

1. In civilized communities no one lives to himself, and governments are necessary.
2. Governments give to their citizens many advantages that they otherwise could not have, and they prevent the ignorant and selfish citizens from harming others.
3. In a government each citizen is a partner.
4. The preservation of the public health is one of the first duties of a government.
5. Public health officials are necessary to carry out sanitary measures.
6. Good citizens should support health officials.
7. Sanitation is economical, for it is cheaper — very much cheaper — to prevent most germ diseases than to suffer from them.
8. Sanitation is sensible.

CHAPTER XXXIV

WHAT GOVERNMENTS CAN DO TO PRESERVE THE PUBLIC HEALTH

Just what a government should do to preserve the health of its citizens depends on whether the people over whom it is watching live in the tropics or in the colder portions of the earth, and on whether they are in cities and towns or in the country. Yet the principles of sanitation are everywhere the same — *the government must do those things that are necessary to the health of the community which the people cannot do for themselves*, and *it must compel every one to live in such a way that he will not be dangerous to others*. From your study of former chapters of this book you will understand many of the duties of a government that are connected with preserving the health of a people. We will, however, point out a few of the more important ways in which a government can save its citizens from disease.

Quarantining in cases of epidemic diseases. One very important duty of a government is to quarantine cases of epidemic diseases. If you had a handful of weed seeds in a cup, you could easily destroy them by throwing them into the fire. But if some one should scatter these seeds over your garden and lawn, it might be a work of months to get rid of the weeds that would grow from them. So in epidemic diseases it is easy to quarantine a single patient and keep the germs from being spread abroad, but it is very difficult to control some of these diseases after the germs have been scattered. Some

physicians, even, do not appreciate the importance of this fact, and instance after instance could be given of great epidemics of disease that could have been entirely prevented if the first cases had been promptly dealt with.

Not only may a community injure itself by failure to enforce quarantine, but it may injure some other community that is far away. The man who started the great smallpox epidemic in Montreal (page 124) came from Chicago, and the man who caused the typhoid epidemic at Plymouth, Pennsylvania (page 88), came from Philadelphia. What we need all over the country and all over the world is such careful quarantining of infectious diseases that they will be driven from the earth. Both for the sake of its own people and for the sake of people in other places, every community should enforce strict quarantine of each case of sickness that has the appearance of smallpox, yellow fever, diphtheria, or other epidemic disease, until it is known that the disease is one that is not dangerous to the public health.

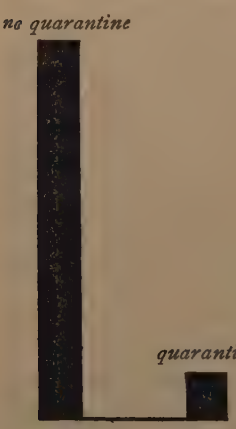


FIG. 106. From 1866 to 1875, when quarantine was not enforced, the average annual death rate from scarlet fever in Massachusetts was 7.7 for every 10,000 inhabitants. From 1896 to 1905, when quarantine was strictly enforced, the average annual death rate from scarlet fever was 1 for every 10,000 inhabitants.

Building hospitals and sanatoria. Governments should build hospitals to which persons who are suffering with severe epidemic diseases can be taken. This not only prevents the spread of these diseases, but is best for the

patients also; for hospital physicians who have made a special study of epidemic diseases have the greatest skill and experience in treating diseases of this kind.

It is the duty of the government also to provide sanatoria where persons who are suffering from long-continued cases of infectious diseases can go. There are 500,000 consumptives in the United States, and in all the institutions of the country there are only 15,000 beds, pay or free, for the reception of consumptives. Our country has no greater need to-day than sanatoria that will stop the spread of this disease and will give its victims the treatment that they need.

FIG. 107. Governments of cities and towns should keep down dust in the streets.

Providing a pure water supply. In the country it is usually possible for a family that is willing to use a reasonable amount of care and intelligence to provide itself with a pure water supply. In cities and in larger towns where the people are crowded together the soil always becomes polluted and well water is impure. It then becomes impossible for each family to secure a safe water supply, and it is the business of the city to furnish a supply of pure water for all the people. If a city fails to do this, many of its people will die of intestinal diseases. For the experience of the whole world is that cities and towns that must depend on shallow wells and

on streams for their water are greatly scourged by intestinal diseases, while cities and towns that have pure water are comparatively free from these diseases.

Providing a system of sewage disposal. It is absolutely necessary for any government that wishes to preserve the health of its citizens to provide some method for the disposal of sewage. Where there is a water supply and a system of sewers, the problem is made easy for each family. Where there is no water and no such system of sewers, the government should take up the work of cleaning out all closets, and should provide carts to haul the matter in them away where it can do no harm. It is not enough for the government of a town to pass laws requiring that all closets be kept in a sanitary condition, for where families live on small lots the only safe way to dispose of the matter in closets is to haul it away, and it is a waste of money to require each separate family to hire this done when the government can have the same work done at a fraction of the cost to the people. In small towns that have no water supply the question of sewage disposal is of special importance. For the sanitary condition of a town is hopeless as long as it has neither a water supply nor a system of sewage disposal. It might be added that a town which provides some way of purifying its sewage before running it into a stream to infect the water supply of

FIG. 108. In a city the government should assist the citizens to keep their premises in a sanitary condition.

another town, is doing nothing more than to follow the Golden Rule.

Collecting vital statistics. In all the leading countries of the world except the United States, a record of all deaths and the causes of them are kept. In nearly one half of our country, statistics in regard to the number of deaths and the diseases that cause them are collected, but in the remainder of the country this very important duty of the government is neglected.

Why vital statistics are important. If typhoid fever is a common disease in your town, the water supply needs to be improved. If a large number of little children are dying from intestinal diseases, the milk supply as well as the water supply should be looked after. If scarlet fever and diphtheria keep interfering with the schools and causing more deaths than they cause in other towns, your health officers are not quarantining and disinfecting as well as they do in other places. If the death rate from malaria is high, a campaign against mosquitoes should be undertaken.

How are we to find out whether or not infectious diseases are more common in a town than they should be? By keeping a record of all cases of these diseases and the number of deaths that they cause and comparing our figures with the figures from other places. How are we to tell which diseases are most important in our communities? By keeping a record and comparing the number of deaths caused by each. No one can tell what diseases are most common in a town without vital statistics. No one can tell whether or not sanitary measures are improving the health of a town as they should unless an account is kept of the number of deaths

in the town before and after these measures are taken. All of us have lived among tuberculosis all our lives, but how many of us dreamed that tuberculosis was as important a disease as it is, until the facts were collected and set down in cold figures? "Let us have facts, real, unmistakable facts; for without facts there can be no true science."

How death rates are calculated. If you should examine the report of a health official, you would probably find in it death rates for the month or year for the city or state as a whole, and death rates for different diseases. At first these death rates may seem a little confusing, but when we understand how they are calculated they are in reality very simple. *The death rate of a country means the number of deaths in that country for each* 1000 *inhabitants.* In 1906 the death rate in the United States was 16.1 for that part of the country in which vital statistics are kept. For the same year it was 15.4 in England and Wales, 9.3 in New Zealand, 24.8 in Hungary, 13.7 in Norway, 19.9 in France, and 26.2 in Spain. This means that in each of these countries there were as many deaths for each 1000 inhabitants as the figures given above show. Name some of these countries in which the sanitary conditions are probably not good.

The death rates that are given for different diseases mean the number of deaths caused by these diseases for each 100,000 *of population.* In 1907 the death rate from typhoid in England and Wales was 6.7. In the United States it was 30.3 (as closely as can be estimated). This means that in England and Wales there were 6.3 deaths from typhoid fever for each 100,000 of population, and in the United States there were 30.3 (nearly five times as

many) deaths from typhoid for each 100,000 inhabitants. In our country the death rate in 1907 was .2 from smallpox, 12.2 from whooping cough, 24.3 from diphtheria and croup, 183.6 from tuberculosis, 26.6 from meningitis, and 161.2 from pneumonia.

Which of these diseases is it most important for us to check? Why do you suppose typhoid fever is so much more common in the United States than in England? Look over the table on page 184 and suggest sanitary measures that the people of certain places ought to put into practice.

How to study vital statistics. The best way for you to begin the study of vital statistics is to examine the figures for your own city or town and then compare them with figures from other places. Ask your health officer for a copy of his last annual report and look for the tables showing the cases of infectious diseases and the causes of deaths. Make a table showing the number of deaths from these diseases and compare them with the figures from other places. Then make a list of the sanitary measures that you think would most improve the health of your town. If your health officer has no report of this kind, your town and your state ought to pass laws that will make it possible for vital statistics to be collected. For a health officer who is compelled to do his work without vital statistics is in exactly the same condition that a merchant would be in if he were compelled to run his business without keeping any books.[1]

[1] In some states very useful reports on vital statistics can be obtained from the State Registrar of Vital Statistics at the Capital of the State. Vital statistics for any part of the United States where they are kept and

DEATH RATES FOR THE YEAR 1907

	General Death Rate	Typhoid Fever	Malarial Fever	Smallpox	Measles	Scarlet Fever	Whooping Cough	Diphtheria and Croup	Influenza	Tuberculosis	Meningitis	Pneumonia	Diarrhœa and other Similar Diseases
United States . .	16.5	30.3	2.8	.2	10.3	10.3	11.6	24.3	24.1	183.6	26.6	161.2	116.7
Massachusetts . .	14.5	12.9	1.2	.2	8.7	10.1	11.1	24.9	26.3	183.3	37.4	126.5	127.9
New York City . .	18.7	17.5	1.7	.2	15.7	19.7	8.7	40.2	15.4	242.1	24	156.2	169.2
Chicago	15.3	17.7	.4		12.4	34.1	11.7	26.3	11.3	191.6	22.8	178.4	133.1
Pittsburg, Pa. . .	19.2	130.8	.8		11.5	10.9	37.5	27.9	20.3	139.1	19	140.1	208.4
Charleston, S. C. .	27.2	51.4	24.				33.7	12.4	17.7	338.7	16	131.2	257.1
Richmond, Va. . .	25	43.3	30.1		36.7		1.9	16	54.6	290.9	29.9	189.2	193.9
Indianapolis, Ind. .	15.2	29.4	3.5	.9	20.6	9.2	1.8	11.9	17.6	240.7	14.5	86.5	100.1
Memphis, Tenn. .	19	38.8	100.9		10.1	7.8	33.4	15.5	34.2	199.6	62.9	124.2	109.5
New Haven, Conn.	18.6	30	6.5		4.9	2.4	8.9	29.2	40.5	209.8	34	181.5	93.2
(Your state) . . .													
(Your city) . . .													

The general death rate shows the number of deaths from all causes for each 1000 inhabitants. The death rates for the different diseases show the number of deaths from each of these diseases for each 100,000 inhabitants. In the last two lines fill in the death rates for your state and city.

Reporting cases of infectious diseases. All cases of infectious diseases should be reported to the health officials, and they should keep a record of these cases. Then the officials can know whether children are attending school from a house where there is whooping cough or measles. They can then make sure that houses are disinfected after scarlet fever and diphtheria. They can see that the wastes from typhoid patients are destroyed, and they can do something to help consumptives and to prevent their spreading the disease. Every law providing for vital statistics should require physicians to report all cases of infectious disease to the health officials as early as possible.

Other duties of the government. A government should further guard the health of its citizens by thoroughly disinfecting after cases of infectious diseases, especially by disinfecting houses where consumptives have lived, and it should vaccinate its citizens against smallpox. It should remove or cause to be removed the breeding places of flies and mosquitoes, and where there is danger of plague, it should wage war against rats. It should guard the milk supply, and put in force measures for keeping down dust. It should prohibit spitting in public to guard against consumption especially. Dispensaries where consumptives and mothers with sick babies can be advised and assisted are good investments for any city or state. It is also the duty of a gov-

estimated populations for non-census years for states and cities of more than 8000 inhabitants may be obtained from the annual reports on Mortality Statistics, published by the United States Bureau of the Census. Your health officer probably has a copy of this book, and he will doubtless allow you to copy from it any figures that you may need in your study of this subject.

ernment to provide sanitary school buildings and clean playgrounds for its future citizens, and to have medical

FIG. 109. Cities and towns should provide places where children can play without danger from disease germs.

inspectors keep watch over the children in the schools. Above all else, a government should educate its people in regard to preventable diseases.

POINTS TO BE REMEMBERED

1. A government should quarantine epidemic diseases.
2. It should build hospitals and sanatoria where the victims of infectious diseases may be cared for.
3. It should provide a pure water supply for its citizens.
4. It should provide a system of sewage disposal.
5. It should collect vital statistics.
6. It should carry out such other measures as may be necessary to protect its citizens from preventable disease.

CHAPTER XXXV

PRACTICAL SANITATION

We have now finished our study of germ diseases and of the sanitary methods that may be employed to prevent the spread of these diseases. The question now is, what can a few people do to improve the sanitary condition of a community? All great works take time, and to reform a town that is a total stranger to all sanitary measures usually requires years of patient effort. By intelligent work, however, a community can soon put itself in better sanitary condition and begin to cut down the number of deaths from infectious diseases in the community.

Educating the public. The chief trouble in carrying out sanitary measures is that many people do not understand anything at all about germ diseases. There are in our country many persons who do not yet know that malaria is carried by mosquitoes, or that a person who is only slightly ill, or not ill at all, may be carrying typhoid germs. These persons cannot understand the importance of sanitation. Neither do they carry out sanitary measures intelligently when they do try to improve the healthfulness of their surroundings, for it is an easy matter to look in the wrong place for germs. Every one, therefore, who spreads a knowledge of disease germs is helping the sanitary condition of his community, for where knowledge of disease germs goes, the fear of them and the effort to escape from them will soon follow.

Sanitation in cities. A great city can be kept in sanitary condition only by the government, and a citizen can best serve the cause of sanitation in a city by working through the health officials. The good citizen should use his powers to have honest, intelligent men elected to office, and he should support measures that will give these men enough money to have the health of the city properly guarded. In every city there are candidates for office who seek the support of the people by professing to believe in an economical government and a reduction of the taxes. In many cases it is possible to reduce the taxes only by allowing the schools, the police and fire departments, the streets, the parks and public playgrounds, and other interests of the city to run down, and by turning disease germs loose to work their will on the people of the city. The citizen who wishes sanitation in his city should therefore, first of all, interest himself in the life of the city and see that the right men are given control of public affairs, and he should advocate sanitary measures and everywhere preach the doctrine that public sanitation is not possible without expending public money. The citizen can also best do his part in the great sanitary work which a state and a nation should carry on by upholding faithful health officials and by reporting any who may be lazy or careless about their work.

Sanitation in villages. From a sanitary point of view, the position of many villages and small towns is most melancholy. Enough people have collected in them to make it impossible for any one family to protect itself by its own sanitary efforts, as a family can do in the country. Even in a small town there are enough people

to keep many rain barrels that will breed mosquitoes, many manure piles that will hatch flies, many offensive closets to threaten the health of the town. Enough people can collect about the post office or the store in the smallest village to cover the sidewalk in front of the buildings (and sometimes the floors of the buildings themselves) with expectorations. At the same time, the small town usually has no water supply except wells, no system of sewage disposal, and no health officials who are paid enough and have authority enough to allow them to do much toward preserving the public health.

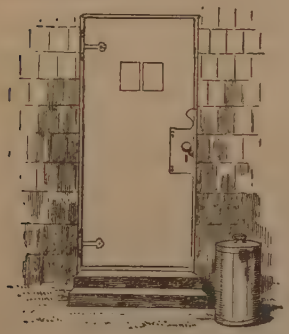
In these towns and villages much may be done for the cause of sanitation by a few intelligent, active workers. Village improvement associations can be organized to study how the town may be made a more healthful and pleasant place to live in. These associations can help to educate the people in regard to consumption and other diseases that are always in the village. They can keep before the public the necessity for having clean playgrounds for small children. They can encourage the people to sod along the sidewalks and to set out trees, and this will help in keeping down the dust. They can use their influence against spitting on sidewalks and can find other ways to assist in keeping the streets clean. Above all, they can uphold the physician who is acting as health officer when some one in the town becomes offended at him, and they can exercise a great influence on the officials of the town. If the members of a town council know that the intelligent people of the town want the breeding places of insects to be removed, the weeds in the streets to be cut down, the closets in the town to

be kept in a sanitary condition, the streets to be sprinkled, and at the earliest possible moment a water supply to be provided for the town, they will be more likely to look after these things than they will if no one thinks or says anything about the health conditions of the town.

Freeing the country farmhouse from disease. In the country unsanitary neighbors are not so great a danger as they are in towns and cities, and by intelligent effort a family in the country can to a great extent free itself from germ diseases. If country families will clear away weeds and dense shrubbery from around their homes, and look after the breeding places of mosquitoes, they can do much to protect themselves against malaria. By removing the breeding places of flies, avoiding the polluting of the soil about their homes, and guarding their milk and water supplies, they can in a great measure free themselves from intestinal diseases. Sunlight admitted to the house is a great aid in keeping the atmosphere free from germs, and the fresh country air admitted freely to the sleeping rooms at night will do much to build up the body and increase its germicidal power. Germ diseases are almost as common in the country as in the city, but with a little care a family in the country can avoid most of them.

The necessity of setting a good example. He who would be a successful preacher of any doctrine must himself be willing to put into practice that which he preaches, and he who would help the cause of sanitation in his community must first of all see that his own premises are in a clean and sanitary condition. The family that keeps a rain barrel to breed mosquitoes need not complain if a neighbor keeps a manure pile for the hatching of flies;

the man who spits on the sidewalk need not be surprised if a passing consumptive leaves a swarm of tuberculosis germs by his front gate; and the family that keeps an offensive closet behind the house is in no position to make a successful fight for better sanitation in the town. The first and greatest service that we can render the



FIGS. 110 and 111. Which of these will permit the people in the house to make the more effective fight for sanitation?

cause of sanitation is to cease to offend against sanitary laws ourselves, and this will not be without profit to us, for, after all, most families suffer from germ diseases more because of their own carelessness than because of the faults of others.

Practical results of sanitation. Sanitation is nothing new, for several thousand years ago the Jews had laws that called for a careful quarantining of lepers, and by sanitary measures cholera, smallpox, yellow fever, and plague have been driven from most of the civilized world. Sanitation has been thoroughly tried and it has been a great success. A world-wide movement for it is now springing up, and those who are pushing this movement

are not asking that untried measures be put into operation. They are merely asking that the same measures that have proved so successful in freeing us from our greatest plagues shall be used to free us from other diseases that still afflict us. Advocates of sanitation need have no fear but that it is possible to prevent most cases of germ diseases, for hardly a disease can be mentioned that has not been either banished or seriously checked in some communities. When we can keep the germs that are in the bodies of the sick from getting to those that are free from these germs, then nearly all cases of germ diseases will disappear from the earth. That it is possible to do this in the great majority of cases, all experience in sanitation abundantly proves.

POINTS TO BE REMEMBERED

1. Education in regard to germ diseases always helps the cause of sanitation.
2. In cities, states, and nations, citizens can best serve the cause of sanitation by supporting the health officials.
3. Small towns and villages are almost always in great need of sanitary reform.
4. In these places much can be done for sanitation by educating the people and by interesting the local officials.
5. Germ diseases are about as common in the country as in the more crowded cities.
6. This is unnecessary, for country air is pure, and a country family can largely free itself from germ diseases.
7. A good example is as necessary in the preacher of sanitation as it is in preachers of other doctrines.
8. Experience shows that by sanitation most germ diseases can be banished or greatly checked.

APPENDIX

BUILDING A DRY CLOSET

So much of our sickness comes from human wastes that the disposal of these wastes is one of the greatest problems of sanitation. This problem is of especial difficulty where there is no sewage system, and a few words on the best methods of constructing a dry closet may not be amiss. The closet should not be on ground that is higher than the house, well, or yard, or water may run from the closet when it rains, and pollute the soil about the house and the well. If germs are to be kept from spreading, it is absolutely necessary that the closet be tightly closed in, and the openings in the seat be covered to keep out flies. The closet should not be too far from the house (150 feet is a good distance), or there is danger that it will not be used, and a closet should not be near a well, — not closer than one hundred feet according to an old rule. Lime should be freely used in the closet, and if this is not to be had, fine dry earth (road dust is excellent for this purpose) should be used. Wood ashes are even better than lime for use in closets, for the lye in the ashes helps to kill the germs and prevents the breeding of flies. It is better if the vault of the closet can be made of cement, so that there will be no danger of the soil's becoming polluted.

The closet should be frequently cleaned, and the matter in it either completely buried (where the drainage from it will not flow toward the house) or spread out on soil at some distance from the house so that it will dry quickly. It is not safe to use this matter to fertilize gardens. No better system of removing matter from closets has yet been found than the "pail system." According to this system galvanized iron pails are placed in the

closet and at certain intervals these pails are removed and other pails left in their places. This work is, of course, done at night in villages and towns.

FUMIGATION

The following is one of the best methods of disinfecting a room with a gas:

For each 1000 cubic feet of room space purchase 4 ounces of potassium permanganate crystals and 8 ounces of formalin (40 per cent solution). Double these quantities will do the work even more surely. Close up the fireplace or stove, and seal all cracks about doors and windows by pasting strips of paper over them or by very carefully stuffing them with rags. Open closet doors, pull out all drawers, and spread out clothing and bed clothing.

Set a metal pail in the middle of the room, put the permanganate into the pail, and turn the formalin over it. A very sharp gas called *formaldehyde* will be given off at once, and the person must leave the room quickly. The door should be closed and sealed and the room allowed to stay shut up for at least five hours. Twenty-four hours is better. This kind of disinfection will not kill germs that are protected by clothing or bedding and should be trusted to disinfect only the surfaces of objects. It does not injure articles in the room and does not kill insects. The Louisiana State Board of Health recommends adding two ounces of gum camphor to kill flies and mosquitoes.

THE PURITY OF ANTITOXINS AND VACCINES

The antitoxins, bacterial vaccines, and vaccination virus sold in the United States (excepting those produced by City and State Boards of Health) are now prepared under the supervision of the officers of the United States Public Health and Marine-Hospital Service. This guarantees the purity and strength of these products, which is a most important matter.

GLOSSARY

This glossary is intended chiefly to help the pupil in the pronunciation of the more difficult terms. A few words are defined. The numbers refer to pages on which will be found text that will help to make clear the meanings of the terms.

anemia (a-nē′mi-a), 137.
Anopheles (A-nŏf′ĕ-lēz), 112.
appendicitis (ap-pen-dī-sī′tis).
bacillus (ba-sĭl′lŭs), 18, 19.
bacterium (băk-tē′ri-ŭm), 6.
bronchial (brŏng′ki-al).
bronchitis (brŏng-kī′tis).
cerebro-spinal (sĕr′e-brō-spī′nal).
coccus (kŏk′kŭs), 18, 19.
communicable (com-mu′ni-ca-ble) disease, *a disease that can be contracted by one person from another.*
corpuscle (kor′pŭsl), 25.
culex (kū′lex), 112.
diphtheria (dĭf-thē′ri-a).
disinfectant (dis-in-fĕct′ant), *something that kills germs.*
dysentery (dĭs′en-tĕr-ỹ), *an intestinal disease in which there is a bloody discharge from the bowels.*
epidemic (ĕp-ĭ-dĕm′ik) disease, *a disease that people catch from one another very easily and which many people have at once. An outbreak of a communicable disease.*
esophagus (e-sof′a-gus), 75.
gangrene (găng′grēn), *inflammation that goes on until part of the tissue is dead.*
germ (jerm), *a bacterium or a protozoön that can cause disease.*
germicidal (jer-mĭ-sī′dal), *germ-killing*, 13.
infected (in-fĕkt′ed), *containing germs, as an infected wound.*
infectious (in-fĕk′shŭs) disease, *a disease, the germs of which can be passed from one person to another.*
larva (lar′va), 110.
larynx (lăr′ĭnks), 33.
lysol (lī′sōl), 160.
meningitis (mĕn-ĭn-jī′tis).
miasma (mī-ăz′ma), 106.
microbe (mī′krōb), *a living thing so small that it can be seen only through a microscope.*
pharynx (făr′ĭnks), 33.
phosphorescent (fŏs-fo-rĕs′ent), 101.
proboscis (pro-bŏs′is), 104.
protozoön (prō-to-zō′ŏn), 7.
ptomaine (tō′ma-ĭn), 82.
pupa (pū′pa), 110.
pus (pŭs), 24.
rabies (rā′be-ēz).
sanatorium (săn-a-tō′ri-um), *a place where people go to regain health; a hospital for the treatment of patients who can be cured.*
serum (sē′rum), 40.
spirillum (spī-rĭl′lum), 18, 19.
sputum (spū′tum), *matter coughed up from the lungs and air passages.*

stegomyia (stĕg-ō′mĭ-ya), 116.
tetanus (tĕt′a-nŭs).
tonsillitis (tŏn-sĭl-lī′tis), *inflammation of the tonsils.*
trachea (trā′ke-a), 33, 34.
trachoma (trā-kō′ma), 97.
tuberculosis (tū-ber-kū-lō′sis), 53.
tuberculous (tū-ber′kū-lus), *infected with the germs of tuberculosis.*
virulent (vĭr′u-lent), *powerful in producing disease.*

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